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JUN 14 1947

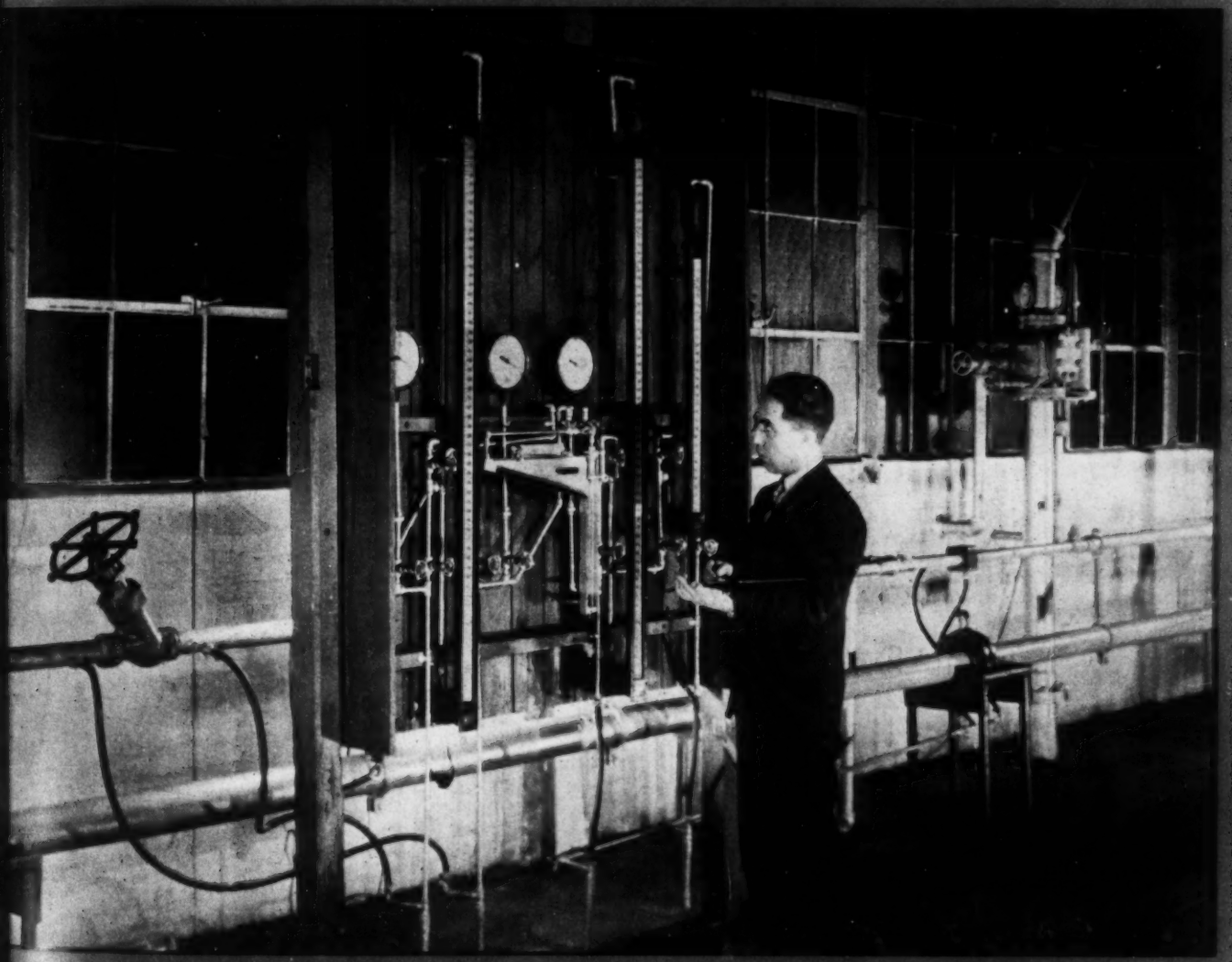
Heating Piping & Air Conditioning

INDUSTRIAL
COMMERCIAL
INSTITUTIONAL AND
PUBLIC BUILDINGS

JUNE ★ 1947

DESIGN
INSTALLATION
OPERATION
MAINTENANCE

103 — Journal Section of the American Society of Heating and Ventilating Engineers



A method of determining pressure losses in valves is among the many subjects discussed this month

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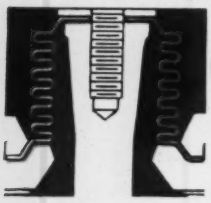
What "Doing One Thing Well" has done for high pressure boilers

Water level control for the high pressure boiler is the toughest challenge of all to "Doing One Thing Well". To work dependably in this service a water level control must be engineered down to the last detail to stand up in the presence of high pressure and the high temperature that goes with it. You have such a control in the McDonnell No. 150. It has been developed through study of operating requirements in countless applications — a dependable basic unit that can be wired as a low water fuel cut-off, as a low water alarm switch, as a boiler feed-pump control, or for any combination of these uses. Here are some of the features that set it distinctly apart:

1 Operating Parts Away From Heat

All operating parts are isolated from the steam and hot water zone. Radiating fins on housing and ventilation of the switch compartment help further to reduce temperature surrounding these parts.



2 Completely Packless

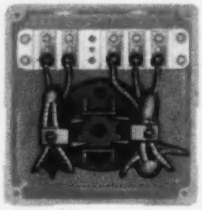
Genuine Sylphon bellows of extra heavy construction totally eliminate packing. Sylphons are held in place by a special mechanical seal which never lets go—a typical refinement.

3 Heavy Welded Monel Float

Capable of withstanding pressures far beyond the rating of the No. 150, the float and rod are made of heavy monel metal, welded for maximum strength.

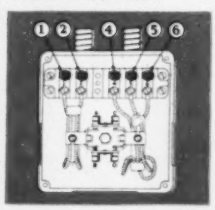
4 Porcelain Insulation on Lead Wires

Another typical refinement of the No. 150, this porcelain bead insulation is impervious to highest temperatures, yet provides ideal flexibility.



5 Dual "Multi-Purpose" Switches

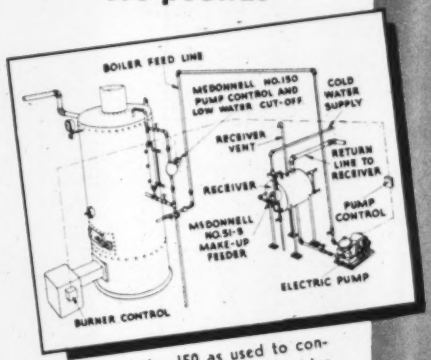
Specially developed for high temperature service, the two heavy-duty mercury switches provide circuits for all purposes—for low water fuel cut-off, pump control, low water alarm switch, or any combination of these functions.



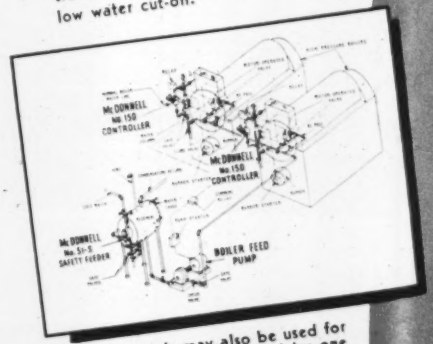
6 Easy To Wire

Easily identified and readily accessible terminals in accurately moulded porcelain panel make wiring easy through two convenient conduit outlets.

For boilers with pressures up to 150 pounds



McDonnell No. 150 as used to control an electric pump. Also provides low water cut-off.



No. 150 controls may also be used for two or more boilers supplied by one feed pump. Simple wiring instructions available.

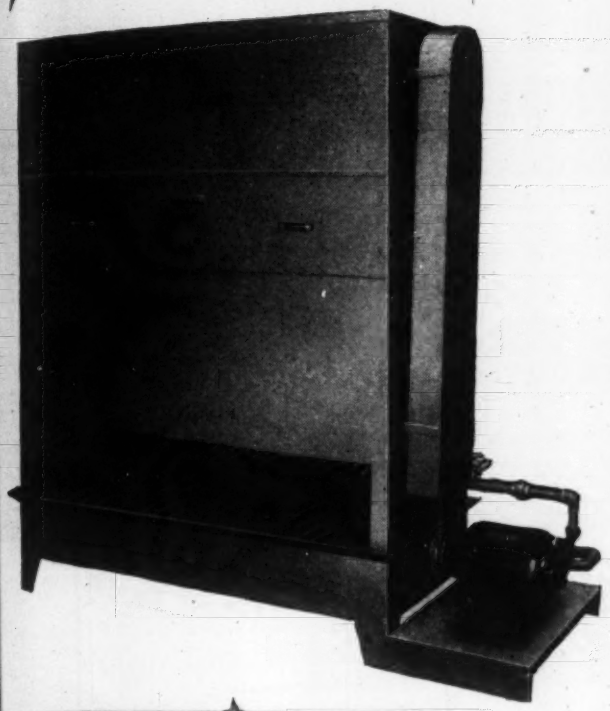
McDONNELL & MILLER, INC., 1316 Wrigley Bldg., Chicago 11, Illinois

Your Jobber Stocks Them

Doing One Thing Well

McDONNELL *Boiler Water Level* CONTROLS

usAIRco



Evaporative Condensers

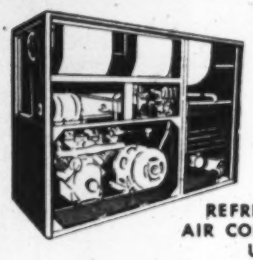
More Efficient Condensing of Refrigerants PLUS Big Water Savings . . .

The evaporative condenser is a "packaged" unit in that it incorporates all the desirable features of the conventional shell and tube condenser, water cooling tower and water pump in a single, compact piece of equipment.

Savings up to 95% in water costs are possible with the use of evaporative condensers for refrigeration or air conditioning applications. They also eliminate waste-water disposal problems, and pumping costs are much lower than those of a conventional cooling tower installation.

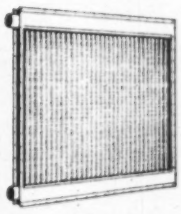
usAIRco Evaporative Condensers are designed for maximum economy and efficiency in operation. An unusually generous amount of coil surface, made up of all prime condenser surface, plus ratings for low condensing temperatures to minimize scaling, provide highest condensing efficiency. Blowers are accurately balanced for quiet operation; forwardly-curved blade design moves larger volume of air at less power cost.

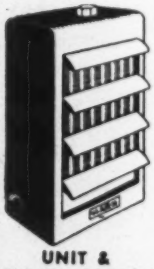
Complete design and engineering information may be had on usAIRco Evaporative Condensers by requesting a copy of special bulletin.



REFRIGERATED AIR CONDITIONING UNITS

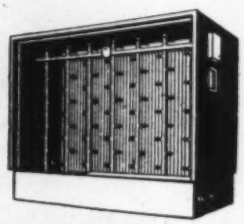
HEATING & COOLING COILS





UNIT & BLAST HEATERS

BLOWERS & FANS



AIR WASHERS

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usAIRco EQUIPMENT

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modern design with low silhouette...

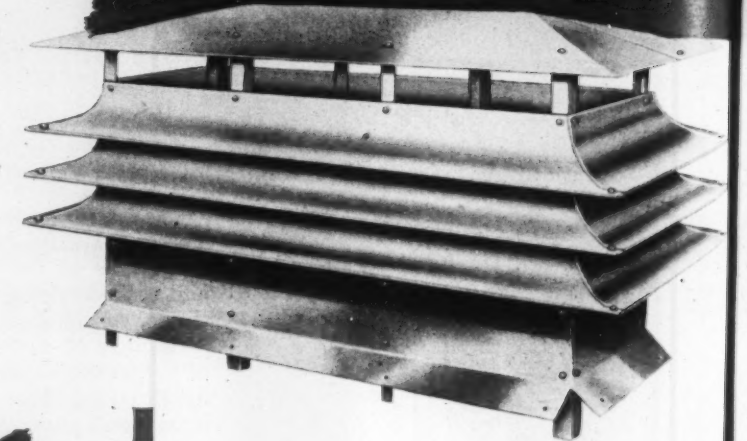
AIRJET

ROOF VENTILATORS and VENT FLUE CAPS

Airjet Roof Ventilators and Vent Flue Caps are designed to conform to present and future architectural demands. They are high-grade ventilators, moderately priced, for commercial and industrial buildings. They are the *only ventilators aerodynamically sound in design. Airjets actually set up a jet of air.*

CHECK THESE PROVEN DESIGN FEATURES

1. modern design—streamlined
2. low silhouette (cannot be seen from street)
3. machine-made, volume production (uniformity and low price)



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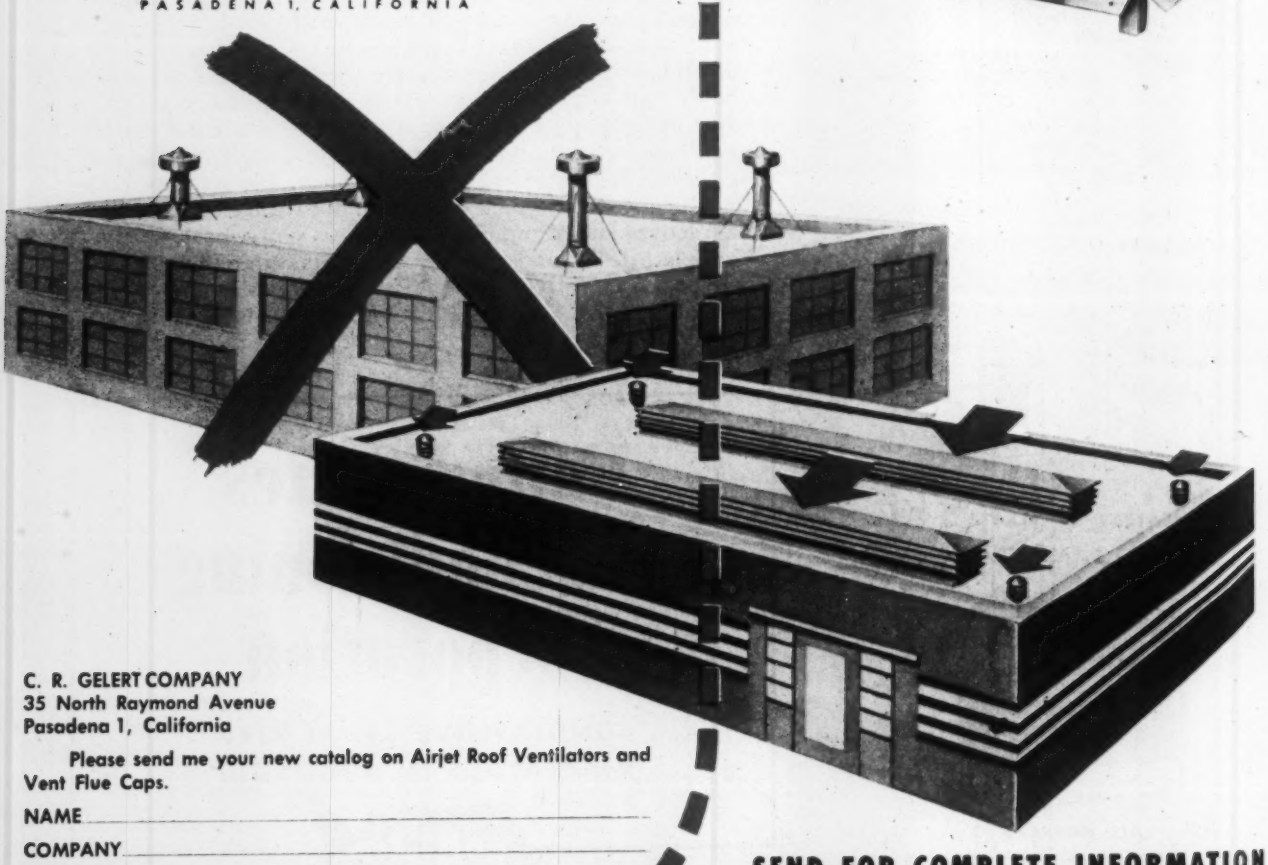

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Also, see Architectural and Mechanical Sections of SWEETS 1947 catalog.

THE EDITOR'S PAGES

"CONSTRUCTION RECESSION DUE TO RISE IN COSTS"

Evidence of a recession from the high volume of construction indicated earlier in the year was reported last month by the F. W. Dodge Corp. on the basis of a study of data compiled from project contracts awarded in the 37 states east of the Rocky Mountains.

The severity of the drop is shown in a compilation of contract volume, which was maintained at a rate of 24 million dollars per business day in the first three weeks of April compared to 28 million in March and 33 million in April of last year. The decline is general, affecting nonresidential building, residential building, and heavy engineering construction.

An analysis of the trend, prepared by Thomas S. Holden, president of Dodge, states:

"Despite the favorable record for the first quarter as a whole, the month of March actually marked the beginning of the downward movement. This readjustment was accelerated in April.

"In view of the known demand, the only important reason to which the recession can be ascribed is the rapid rise in costs in the last six months. Early hopes that price and wage increases would be moderate after removal of controls were not realized. There was evidence of stabilization of some prices in the first quarter, but progress was too slow to stimulate a second-quarter upturn.

"It is now obvious that the stabilization of costs essential to full construction industry recovery is being affected by the refusal of buyers. Buyers have assumed control of the construction market.

"Depth and duration of the current recession will depend on the speed with which price and cost adjustments are made. There has been a wide variation in the rises of various materials, some having been moderate, others fantastic when compared with prewar levels. Price adjustments in varying degree will have to be made by producers, wholesalers, and retail dealers.

"Hourly wages in the building trades are not likely to be reduced. In fact, increases are being asked by a number of trades in scattered areas. The strongest hope for reduction of site labor costs lies in improved efficiency. Production per man-hour has been reported at 30 to 50 per cent below normal in recent months. With stabilized material markets and normal or near normal labor efficiency, contractors again will be enabled to make competitive lump sum bids.

"While the present recession has the characteristics of a postwar price stabilization movement, it is believed by many economists for important reasons that necessary adjustments will be made this time without the extreme deflation of 1920 and 1921.

"Duration of the recession is variously estimated. If present maladjustments in construction costs can be corrected in six months, which is conceivable, the industry should come through without serious trouble. Construction demand and available investment funds are factors favoring a short, rather than prolonged, adjustment period.

"The big second-quarter bulge in contract volume last year is not likely to be repeated this year. There is some question whether the total dollar volume of work started in the current year will exceed that of 1946 appreciably."

CENTRAL REFRIGERATION, STEAM FOR CHICAGO?

A scheme for central generation of steam, electricity, and refrigeration for downtown buildings in Chicago is pending before the city council and is backed by the Chicago Loop Cooperative Association. According to I. L. Wise, the association's chief engineer, steam would be generated at strategic spots at high pressure, passed through turbines as reducing valves, and then used for building heating. Refrigeration for air conditioning would be provided in summer. Idle tubes of the Chicago Tunnel System would be used to convey the steam, refrigeration, and electric lines to the various buildings.

Advantages of the method are said to be an estimated 27 per cent reduction in fuel consumption for heating a building, and a 50 per cent reduction in air pollution as compared with the smaller boiler plants now used. Refrigeration would be made available for air conditioning to many who now lack it "because of high cost and limited sewer capacity." A secondary benefit would be saving the space in buildings now used for stacks and boiler plants.

BIOTECHNOLOGY IS NEW TRAINING FOR ENGINEERS

Interdependence of man and machines, the progressive extension of artificial control of human environment, and the expanding role of the engineer in human affairs are recognized in the teaching and research on human problems of engineering recently inaugurated as fundamental activities in the department of engineering at the University of California. The program, "which represents an effort to develop a biotechnology as a basic discipline in engineering education," was discussed by Craig L. Taylor and L. M. K. Boelter in Science, published weekly by the American Association for the Advancement of Science, vol. 105, no. 2722.

The authors point out that in many phases of engineering, essential design criteria are based upon human physiological characteristics. Ventilation is in part based on respiratory needs, for example, and jointly with heating and air conditioning serves the needs of body temperature regulation and thermal comfort.

It is emphasized by the authors that the primary objective of this program is to broaden the training of the engineer rather than "to inaugurate a new engineering subprofession."

RINDERLE NAMED EXECUTIVE VICE PRESIDENT

The election of Charles Rinderle, Jr., to the position of executive vice president and general manager of Eastern Air Devices, Inc., was announced last month by Hugh G. Hamilton, president.

THE EDITOR'S PAGES

"AL" GIVES THE DOPE ON STEEL CORPORATION

In an informative, easy-to-read booklet, Allegheny Ludlum Steel Corp., Pittsburgh, introduces "Al," a good-humored sort of trademark character who discusses the year 1946.

In 18 pages of well-written text, "Al" manages to say something about employment, wages, insurance, safety, his expenditures for the year, plant improvement, production, research and development, and the outlook for '47.

In a table of facts and figures for 1946, "Al" shows dollar amounts for "taken in," "paid out," and "plowed back"—both totals and average amount per employee week worked.

NAMED VICE PRESIDENT FOR ENGINEERING

Thomas Lord, president of the Lord Mfg. Co., has announced the appointment of Dr. Stephen J. Zand as vice president in charge of engineering.

Dr. Zand has been working with Lord's as consulting vibration engineer since 1933. In his new position he will devote his full time to the company and will be responsible for all engineering, research, and development activities comprising the company's product engineering and research divisions.

REMOVE BUILDING RESTRICTIONS, SAYS BPI

Federal restrictions on nonresidential building should be removed immediately in order to maintain employment in the construction industry, Douglas Whitlock, chairman of the Building Products Institute, stated last month.

"The Housing Expediter is disapproving applications for nonhousing construction at the rate of about $25,000,000 a week or one billion dollars a year at the present time," he said. "Permitting this construction to go ahead would help to offset the temporary reduction in other types of building and provide added employment for building trades workers without interfering with the building of homes for veterans.

"With building materials coming into full production in almost every line, there is no excuse for arbitrarily limiting any kind of construction. The output of some materials which would be utilized in large quantities in nonresidential building already is in excess of the demand.

"Moreover, most non-housing construction that has been held back by the federal limitation order uses relatively little of the more scarce materials needed for home building.

"Removal of the $50,000,000 a week limitation order also will help to speed up materials output and lower manufacturing costs, inasmuch as manufacturers then will be able to return to a balanced production of various grades and types of materials.

"It is imperative that the limitation order be removed promptly because actual construction cannot be started in many cases until several months after the action is taken, and unemployment among building workers already has been reported in some sections of the country."

GAS UTILITIES TO SPEND A BILLION

The gas utility companies are prepared to spend approximately one billion dollars this year in expanding production, transmission, and distribution capacity, according to the American Gas Association. Shortages of materials (principally steel, pipe, and tinplate), overburdening of the nation's transportation system, and delays in obtaining necessary certifications to expand the country's natural gas pipe line systems are seriously obstructing these expansion plans, the AGA said.

The demand for gas for heating, cooking, refrigeration, air conditioning, and automatic water heating is rising steadily, the association stated, and gas utility companies are employing every possible resource to meet this demand. Production capacity of the industry is being increased. Standby facilities for storing liquefied petroleum gases for mixing with other gases to meet peak loads are being installed. New discoveries of natural gas are far exceeding consumption.

There is no shortage of gas, the AGA pointed out. The shortages exist in materials required to transmit and distribute gas to prospective customers.

FIVE DAY WEEK FOR BUILDING INDUSTRY

The building trades' associations affiliated with the Building Construction Employers' Association of Chicago have signed agreements with the various building trades' labor unions calling for a five day, 40 hr week.

Due to a shortage of mechanics, a situation arose which caused employers to compete for labor by offering a greater number of hours of work per week and other inducements. This action has created a chaotic condition that has proven costly to all builders, according to the BCEA.

As of June 1, the association is asking everyone connected with the building industry to observe the five day, 40 hr week, except in cases of extreme emergency.

"THE CUSTOMER IS BOSS"

A series of 13 shop posters on the theme that "the customer is boss" was created by the Parker Advertising Co., 308 W. Monument Bldg., Dayton 2, Ohio, for the Delco Products Div. of General Motors and is now available to other manufacturers.

One of the posters points out that "When you're the customer, you're the boss. You decide where to buy and where not to buy. You demand full value and fair treatment. It's just the way with our customers. If they don't like our products and prices, they'll go somewhere else to buy. So we've got to satisfy our customers to hold on to our jobs."

E. F. SCHAEFER ELECTED PRESIDENT

Edgar F. Schaefer, formerly executive vice president of Gardner-Denver Co., has been elected president, and H. G. Myers, former president, has become chairman of the executive board.

Heating Piping & Air Conditioning

with which is merged the Aerologist

Design, Installation, Operation, and Maintenance: Industrial, Commercial, Institutional, and Public Buildings

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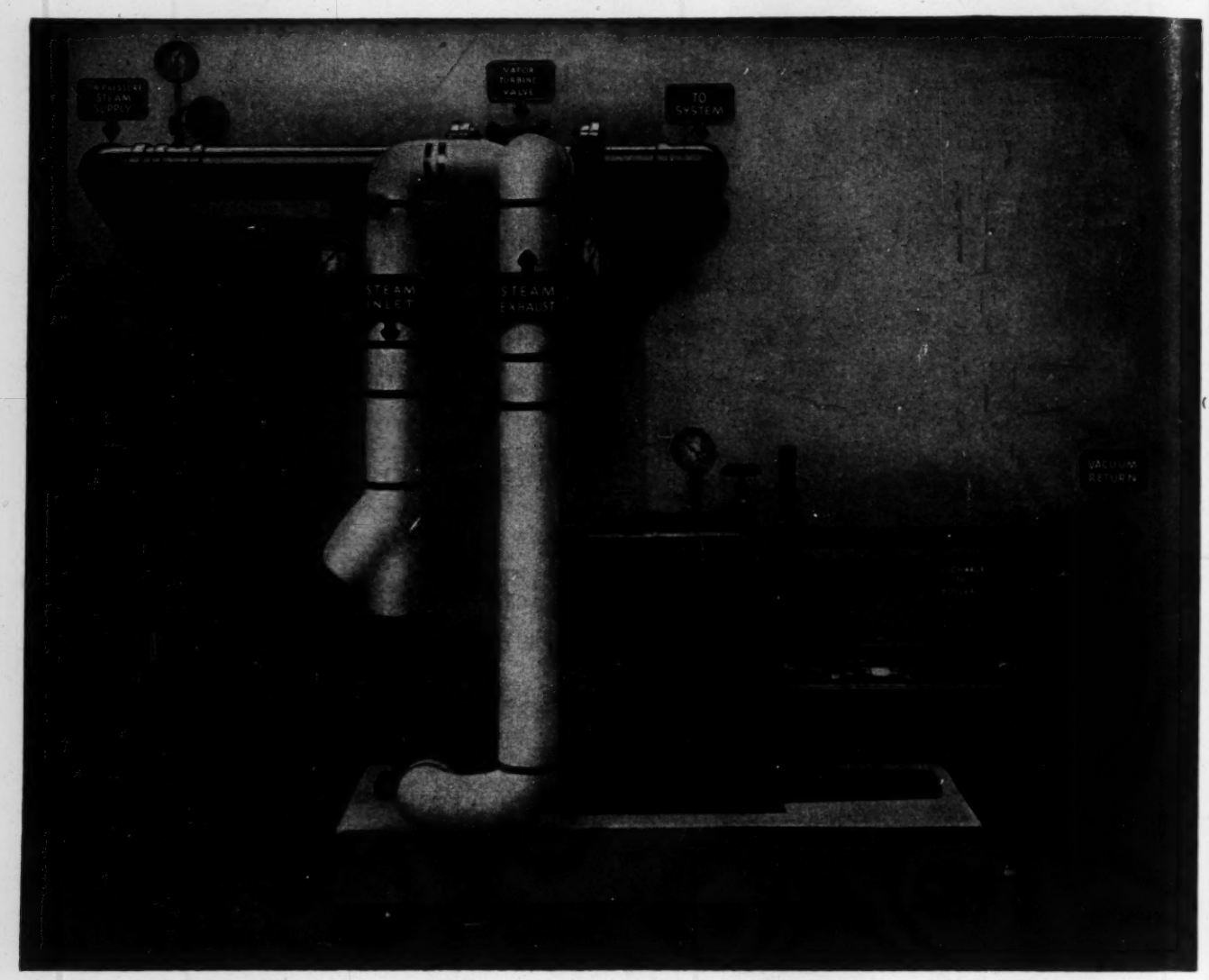
Interrupted Electric Service will not stop this NASH Heating Pump



In Hospitals, Greenhouses, Schools, Public Buildings, Theatres, wherever heating systems must not fail, install the Nash Vapor Turbine, for it is independent of electric current failure, and continues to operate as long as there is steam in the system.

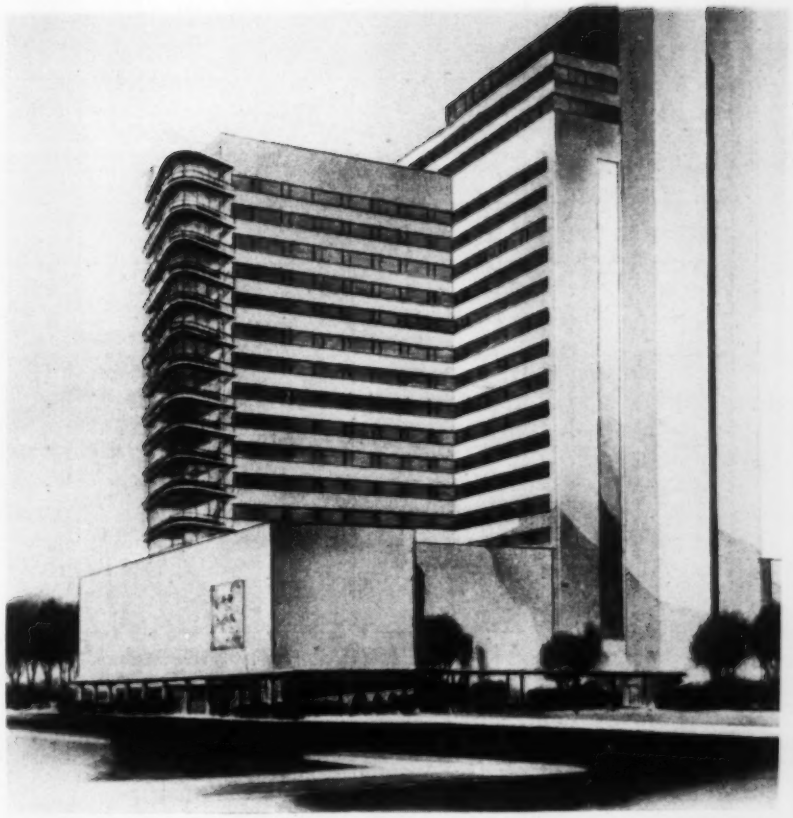
This is because the prime motive power of this economical pump is a special steam turbine, controlled by a unique "Vapor Turbine Valve", which automatically bypasses from the heating main a small portion of steam, the exact amount necessary to develop the power needed to remove the condensate and maintain the required vacuum on the system. Even this small amount is passed immediately back to the mains, and goes on to the system with little heat loss. This pump operates on any system, high or low pressure.

The Vapor Turbine is a most economical pump, for the elimination of electric current does away with current cost, the largest single item in the operation of an ordinary return line heating pump. Bulletin on request.

THE NASH ENGINEERING COMPANY

205-A WILSON ROAD, SOUTH NORWALK, CONNECTICUT, U. S. A.

THE PROBLEM OF vertical air distribution in a tall building is entirely different from that of horizontal air distribution, and in this article a method of analysis is described. The author, a graduate of the University of Minnesota and mechanical engineer for Ellerbe and Co., architects and engineers, developed this vertical duct design analysis in connection with the ventilation and air conditioning systems in the 20-story Kahler hospital building, Rochester, Minn. The work was prepared for publication with the assistance of John Dawson, chief engineer for the same firm. A second article will complete the discussion.



William Sturm, Mechanical Engineer, Ellerbe and Co., Architects and Engineers, Presents Method of Analysis

VERTICAL AIR DISTRIBUTION in Tall Buildings

STACK EFFECT, which varies with outdoor conditions and the varying delivery temperatures of air supplied through duct work to air conditioned or air heated buildings, presents a problem of vertical air distribution in relatively tall buildings which is entirely different from that for horizontal air distribution.

In multistory, multiroom buildings where only ventilation systems of supply, exhaust, or both, have been employed in the past, no one was very much concerned when they discovered that the lower floors exhausted more air than was calculated, and the upper floors less—or even that during cold weather the exhaust systems would supply air to the upper floors instead of exhaust as designed. No one was concerned about these peculiarities because in most cases those rooms which exhausted considerably more air than was calculated were comfortable the greater part of the year until the infiltration rate in extremely cold weather resulted in excessive temperature differentials within the building and some drastic measure was necessary to compensate for this excessive infiltration. This measure consisted of shutting down the exhaust system in the colder weather—and even the supply system, if there was one, because it cost too much to heat all that air anyhow.

The benefits derived from shutting down the ventilation systems resulted in some saving of fuel with fair ventilation on the lower floors by virtue of infiltration and questionable ventilation on the upper floors by virtue of air passing from the lower floors to the upper floors and outside by exfiltration.

In most cases when such ventilation systems were shut down in the colder weather, the infiltration-exfiltration process was still excessive, because air would enter the large ducts at the lower floors, pass up through the ducts, and discharge into rooms at the upper levels from whence it would pass out of wide open windows — opened in an attempt to eliminate the musty, hot, dead, air condition so prevalent at the upper levels.

This difficulty consequently was countered in many places by closing these bothersome shafts through the building simply by placing sheet metal plates under the register faces in all rooms—forever closing the mechanical ventilation system.

Calculate Pressure Differentials

In designing a vertical air distribution system, either supply or exhaust, one should first calculate

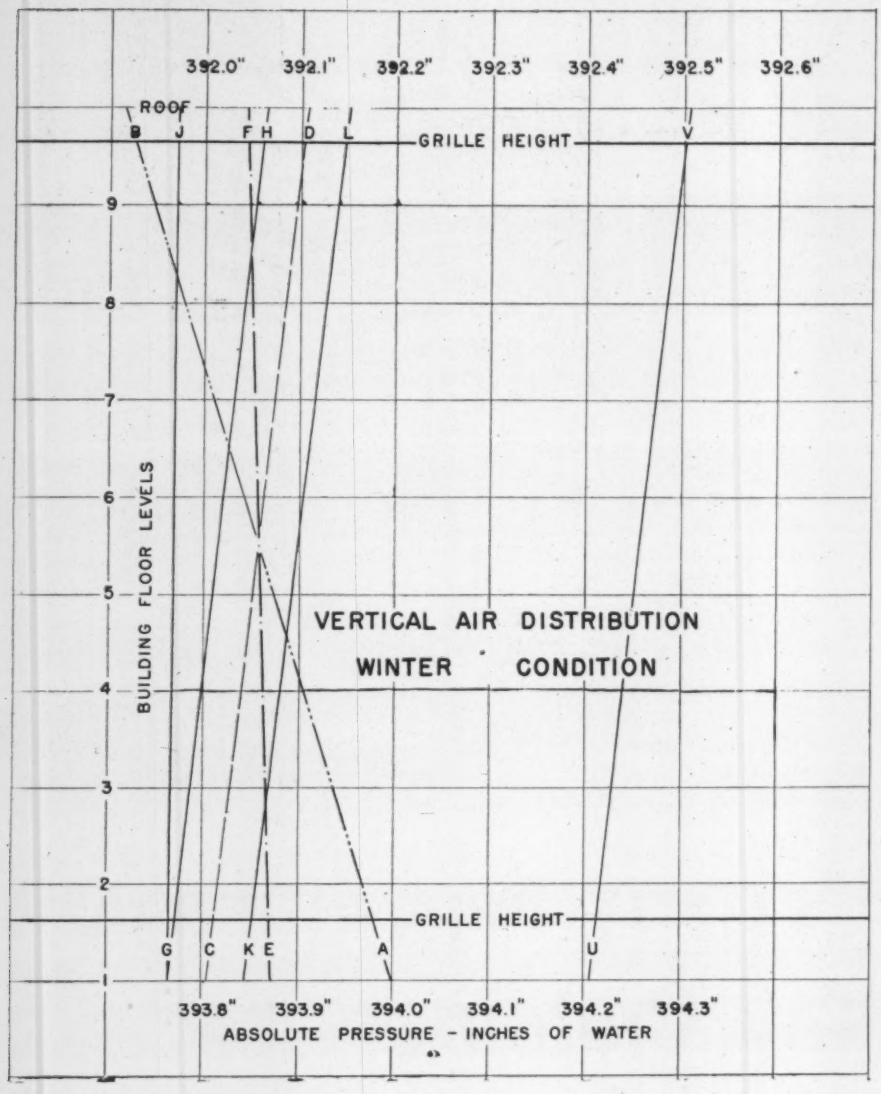


Fig. 1—How the lines for pressures at various points in a nine story building for winter conditions, as shown in this chart, are determined is explained in detail in the text.

what pressure differentials will be encountered in the building in question by determining the weights of the various columns of air at different temperatures and properly relating them to one another.

These air columns for the height of the system involved, at extreme conditions of temperature (which should be the limit of the design) are: the outdoor air at minimum design temperature, the average building temperature corresponding to this outdoor minimum; the maximum temperature of the supply system if such is employed; and if cooling is employed, the outdoor maximum design temperature, the average building temperature, and the minimum design air supply temperature.

Such a design procedure is involved only with those air distribution systems in tall buildings which have ducts passing vertically through the building. It includes the design of the vertical trunk risers which have horizontal distribution takeoffs at each level, and vertical branch risers which are collected at one level to enter the fan intake or discharge.

It will prove incorrect to use the standard duct design methods as employed for the average horizontal job, in a building with a vertical distribution system for air conditioning and/or heating and, to a lesser degree, straight ventilation which feeds several floors. The more floor levels involved, the more serious becomes the problem. The alternative other than the general method described in this article is to design the job in individual horizontal zones of not more than two or three stories in height with each zone having its own fresh air intake and exhaust air discharge within its respective level. Also, even with this method, care will have to be exercised to make certain that the systems are operating against sufficient static pressure.

Weights of Air Columns

Weights of air columns are determined by the formula:

$$W = \frac{G \times H}{5.1925}$$

or

$$W = \frac{H}{[V_a + (V_s - V_a)\,RH]\,5.1925}$$

where G = weight in lb of 1 cu ft of air at temperature in question, including humidity; H = vertical height in ft through which the system extends; V_a = volume of 1 lb of dry air at temperature in question; V_s = volume of 1 lb of saturated air at temperature in question; RH = relative humidity of air in question; W = weight of column of air in question converted to inches of water column; 5.1925 = approximate weight of 1 sq ft of 70 F water 1 in. high, lb.

As an example, the weight of a column of air at 75 F and 30 per cent relative humidity in a nine story, 13 ft, 4 in. per story height building, totaling 120 ft, would be:

$$W = \frac{120}{[13.47 + (0.4 \times 0.3)]\,5.1925} = 1.7 \text{ in.}$$

In a like manner the weights of columns of air at the following conditions would be:

Outdoor minimum temperature, minus 10 F: 2.086 in.

Outdoor maximum temperature, 95 F, 30 per cent relative humidity: 1.623 in.

Duct supply heating maximum temperature, 130 F, 20 per cent relative humidity: 1.502 in.

Duct supply cooling minimum temperature, 55 F, 90 per cent relative humidity: 1.758 in.

Indoor temperature, cooling season, 80 F, 40 per cent relative humidity: 1.675 in.

Pressures Are Plotted

With the above information, we proceed to the next step—which is relating these weights to one another so that a composite picture can be made from the calculations. This can be done mathematically, but a graphical method proves much simpler and presents the problem more clearly.

A typical graph is shown in Fig.

1. On this chart the abscissa are absolute pressure in inches of water and the ordinates are story heights drawn to any convenient scale. Note that the upper and lower scales of pressures are not referred to the same origin; therefore, pressure differences but not absolute pressures can be measured and read at intermediate floors. In this chart atmospheric pressure at the first floor was assumed to be 14.2 psi, which equals 14.2x2.31x12 = 394 in. of water, represented by point *A* on Fig. 1.

Since there is a naturally decreasing absolute pressure as one ascends into space, and if we start at 394 in. pressure at the first floor of the building in this problem, we would have 394 — 2.086 = 391.914 in. of pressure for –10 F air at the top of the building shown at point *B*. This line *A-B* on Fig. 1 is a reference line for outdoor pressures.

The next step is to show the line representing the absolute pressure within the building if the conditions were static with the envelope of the building sealed except for one opening at the mid-height. This line will then be located on the chart in its proper relation to the outside pressure line *A-B*.

This is done first by taking the difference in the weights of these two columns of air outside at –10 F and inside at 75 F or 2.086 — 1.7 = 0.386 in. We then take this difference and assume that the mid-height of the building would be a point of equal pressure for inside and outside columns. To construct this line would then require subtracting one-half of this difference, 0.386 ÷ 2 = 0.193, from the starting point *A*, 394.0 — 0.193 = 393.807, and adding half of the difference to point *B*, 391.914 + 0.193 = 392.107 in.

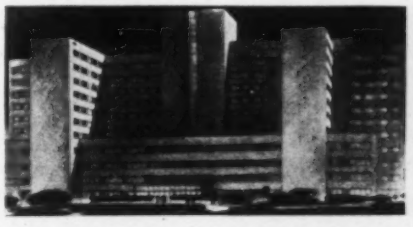
The distance between lines *C-D* and *A-B* now represents the pressure differences between outside and a shaft in the building, positive at the top half and negative at the bottom half, and the actual pressure difference for any particular level can be scaled directly from the chart. This suggests that infiltration occurs increasingly greater toward the base of the building and exfiltration increasingly greater toward the top, with an equal pressure condition at the mid-height of the building.

Pressures Creating Air Flow

However, these lines represent the temperature heads of these two air columns with the distance between them being the pressure difference. However, this is not the pressure difference left to create air flow. The amount left for air flow is dependent upon how the building is constructed, how well the shafts through the building obstruct air flow, and how tightly closed the outside openings (such as doors and windows) remain.

Concerning this amount of pressure remaining for air flow, the ASHVE's Heating, Ventilating, Air Conditioning Guide suggests in the equation in determining relative infiltration in tall buildings that one-half of the actual temperature difference head is allowable for actual pressure head.

If the outside envelope of the building in question is well constructed, it is very likely that less than one-half of the temperature difference head could be estimated as actual resultant pressure head for air flow from building spaces to vertical shafts. In our calculations, let us assume one-third of the temperature difference head, and to illustrate this, we draw the line *E-F*, which represents the pressure throughout the height of the building tending to create infiltration and exfiltration, which will also upset vertical air distribution systems of normal design. On this example it would indicate that the envelope resistance would be twice the inner resistance, which could be very well found in practice.



Actually, the infiltration - exfiltration process in a building, as well as pressure differentials inside and out, are dependent upon three factors: the temperature differentials existing between inside and out, the resistance of the exterior walls or envelope of the building to air flow in or out, and the resistance of the inner construction of the building to prevent air flow passing from one level to another.

If a temperature differential exists, we could have one extreme example of a chimney which has a high envelope resistance and practically zero inner resistance, with only the side wall friction to the flow of gases involved. In this example the temperature differential head is causing air or gas flow and pressure differentials between inside and out are at their maximum. In such an example, during air flow through a chimney, the pressure reference line *E-F* would approach the reference line *C-D*, and if the air flow were momentarily cut off, line *E-F* would coincide with line *C-D*. After this cut off of air flow, the pressure difference between lines *A-B* and *C-D* would remain as indicated until the temperature of one or both of the air columns changes.

The other extreme would be to have a building constructed with solid flooring at all levels offering maximum resistance to vertical air flow and the envelope of the building constructed with numerous openings which would allow air flow or equal pressures through the outer envelope between inside and out. This would result in pressures inside the building being equal to outside pressures at any level with no air flow or chimney effect taking place. Inside resultant pressure reference line *E-F* in this example would coincide with the outside pressure reference line *A-B* until a shaft were cut through the building to allow flow of air through it.

In actual building construction and occupancy, we arrive at a medium condition somewhere between these two extremes just illustrated. This medium condition depends on the relation of the envelope resistance as compared to the inner resistance. If the envelope resistance is great and the inner resistance small, the points *E* and *F* would result close to points *C*

and *D*, respectively. If the opposite condition exists, and the envelope resistance is small in comparison to the inner resistance, points *E* and *F* would then fall close to points *A* and *B*, respectively. This indicates that distances *AE* and *BF* represent the relative resistance of the envelope of the building and distances *CE* and *DF* the relative resistance of the inner structure of the building.

This line *E-F* is a reference line for inside building pressures when the outdoor air is at –10 deg and line *EF* intersects both *A-B* and *C-D* at this point of intersection, with *E* being one-third of the distance from *C* to *A*, and *F* one-third of the distance from *D* to *B*. The horizontal distances between the lines *A-B* and *E-F* indicate the actual pressure differences at each level to create air flow, either outward or inward, depending upon the floor level in question. From these two lines one can determine the velocity of air entering an opening at the base of the building by measuring the pressure difference *AE* = 0.13 in. water column pressure difference and applying the formula:

$$\text{Velocity} = 1096.5\ \sqrt{p/u}$$
$$= 1096.5\ \sqrt{0.13 \times 11.34}$$
$$= 1330 \text{ fpm}$$

where p = pressure, in. of water; u = density of air, lb per cu ft; and 11.34 = volume of — 10 F air in cu ft per lb.

This inward velocity occurs at the base of a building only if there are openings at the top for a like weight of air to exfiltrate, and if the openings in the envelope increase in size, the envelope resistance will decrease as will the entering air velocity at the base.

In a like manner, the velocity of air passing into a vertical shaft from the building space would be represented by the distance *CE* and can be calculated by the formula used above.

Next let us install a system of exhaust ventilation in this building, and for simplicity of illustration let us assume that the vertical duct is frictionless (which is relatively true in numerous installations where velocities are so low as to result in negligible duct friction losses).

Consider a Toilet Exhaust System

Now, allow the problem to be similar to one found in practice where a vertical trunk duct is exhausting air from toilet rooms which are located one on each floor directly above one another.

We will all agree that to instigate air flow from the toilet room into the duct, a negative pressure difference must exist across the register face. As in usual design, let us pick a face and damper which has a total pressure drop of 0.04 in. To represent this pressure difference, the line *G-H* can be drawn on Fig. 1, and since the air will be the same temperature as that in the building, its slope on the chart would be similar and parallel to line *C-D*. Since the pressure in this duct must be less than that in the building, this condition can be drawn on the chart at 0.04 in. less total pressure than that indicated by line *C-D*. This line *G-H* represents a frictionless or constant static pressure duct, and if it is otherwise, the friction loss can actually be shown on the chart by sloping the line either to the right or left, depending upon the fan location in the building. This example is described below.

If we do have an average duct installation with a reasonable amount of friction and assume it amounts to 0.075 in. per 100 ft of duct and that we have a nine story building whose floor to floor heights are 13 ft, 4 in., this would mean a friction of 0.01 in. per floor. If the fan were located at the top, this duct can be indicated by line *G-J*, where we start with a pressure of 0.04 in. less than apparent building pressure *C* at the base, and end with a pressure of 0.14 in. less than *D* at the top.

A study of this condition reveals that something would have to be done to prevent too much air from being taken in at those outlets near the fan, and this is normally done by dampering. If this dampering is done accurately, 0.1 in. resistance would have to be added by the dampers on the roof, 0.09 in. on the 9th, 0.08 in. on the 8th, and so on down the line to 0.0 in. on the 1st, to make the actual pressure difference from the room to the trunk duct equal on all floors, which would result in uniform air flow through openings of equal area.

This brings us right back to where we started with line *G-H*, and everything would be fine for this condition if the system were horizontal or if the outdoor temperature were equal to that indoors. This would mean that each typical toilet room would have an equal amount of air removed, which is the intended and desired condition.

By inspection of Fig. 1, we can see that as the outdoor temperature lowers, the pressure differences across the openings from floor to floor are altered, and uniform air volumes would no longer result. In this specific example, the actual pressure differences at each level would be represented by the distance between the building pressure reference line *E-F* and the duct pressure line *G-H*.

Measurements show that about 0.1 in. negative pressure exists at the ground floor grille height, indicating that air entering the building entrances and windows at that level is endeavoring to find its way up any available shaft in the building to leak out of windows near the top of the building. This pressure difference, as we see, changes to positive near the 9th floor, meaning that some air is actually passing from the duct to the building space, and this amount is not being handled by the fan and is passing out of windows at the upper level, contrary to a designer's good intentions. Many individuals have had direct experience with systems which do just that when the atmospheric conditions cause this peculiarity.

Now if all openings in these typical toilets were equal in area and –0.04 in. resistance or –0.04 in. converted to velocity pressure would result in the proper air flow, which we would need according to the register size picked, a resistance of —0.1 in. at the first floor of the building would result in too high an air quantity exhausting at that floor, and +0.02 in. at the top would result in air actually being supplied at the 9th level.

This would not be a very satisfactory toilet exhaust system; however, the reader must remember that this freak operation occurs only during the colder weather and progressively improves as the seasons change and the outdoor temperature begins to equal that inside the building.

[A second article will discuss summer conditions and recommended solutions.]

High Temperature Water for Radiant Heating System

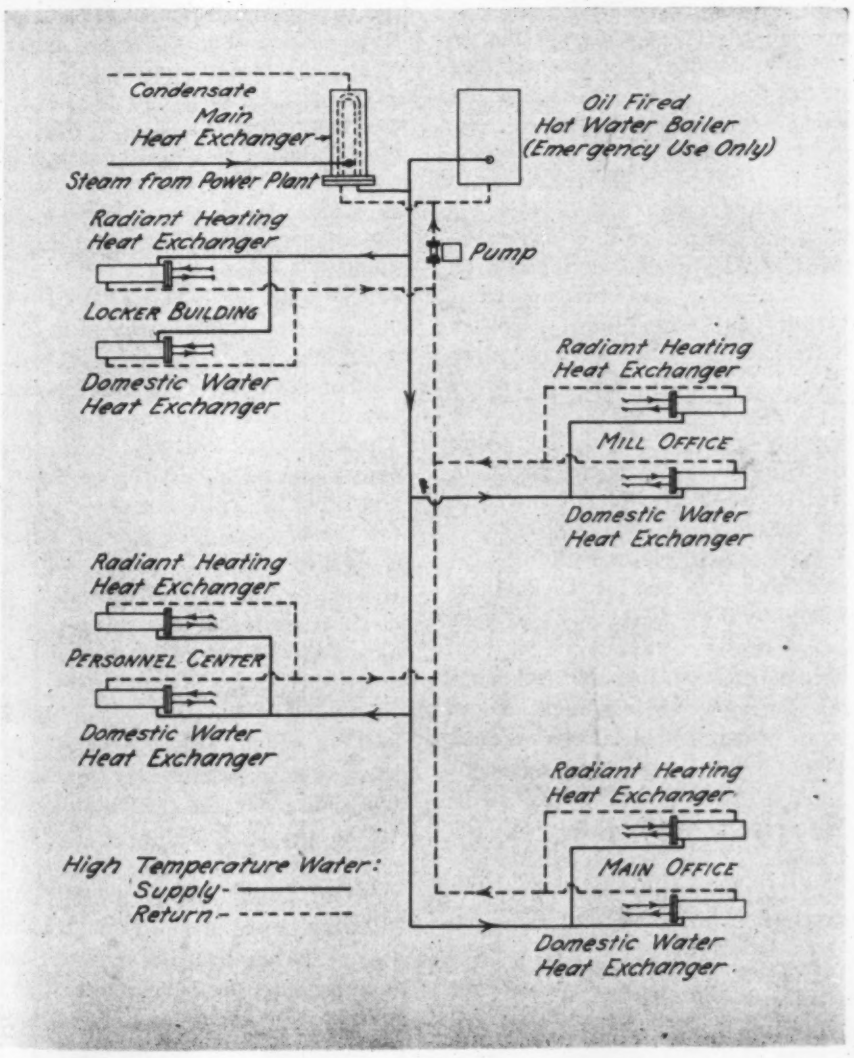
A NEW DESIGN for radiant heating applications in industrial plants—aimed to reduce both installation charges and maintenance costs—has been developed by The Rust Engineering Co. for the mill of the Container Corp. of America at Fernandina, Fla. The new system, now being installed, utilizes high temperature water as the heat source.

This installation will serve a group of four buildings—the main office, mill office building, personnel center and medical facility, shower and locker building, where radiant heating coils are installed in the floors.

The high temperature water is brought to the desired temperature by plant steam in a central heat exchanger. An oil fired hot water boiler is installed for standby operation during a shutdown of the main plant. The heated water circulates to the individual buildings, where it is transferred by heat exchangers to water in the coils of the radiant heating systems.

The water on the main circuit then returns to the central heat exchanger for reheating, and the circuit is repeated. The same high temperature water will also be used in this installation to heat domestic water and to temper air for ventilating systems for the mill.

The high temperature water is circulated to heat exchangers in four buildings



Total heat load of the entire system is 2,080,000 Btu per hr. The main heat exchanger and boiler are designed so that either one will carry the full load and are capable of delivering water at 240 F to the individual building heat exchangers.

Temperatures required in the grids range from 110 to 130 F. Domestic hot water temperatures range from thermostatically controlled shower water at 100 F to a storage water temperature at 140 F. Ventilating air is tempered to between 70 and 85 F by circulating 240 F water through coils in the ventilating system.

Individual boiler circulating pumps have been provided for each radiant heated area. The pump arrangement and a series of bypasses permits any pump to be taken out of service temporarily without materially affecting the overall system. This same pump arrangement allows summer operation of domestic water heaters using only one pump for the complete system.

The high temperature water is controlled at each building by angle metal disc globe valves and motorized modulating flow control valves. Each of the four heating systems will have an outdoor thermostat connected through an automatic reset panel to control the temperature of the water leaving the radiant heat exchanger. The radiant circulators will be controlled by a room thermostat, with a thermostat embedded in the floor to limit slab surface temperatures to approximately 90 F. Circulators will cut out when the three-way mixing valve to the grid supply is in a full bypass position.

A temperature indicating panel board in the boiler room will give outdoor temperature, boiler water temperature, and temperatures of the water returned from each building. This panel also provides manual control for boiler pumps and the standby oil burner.

A NEW APPROACH

Pressure Losses in Valves

By E. B. POOL

THE TESTING equipment and method of analysis described here by Mr. Pool, research engineer, Edward Valves, Inc., permit accurate prediction of pressure losses; calculations are greatly simplified by the use of a special slide rule. . . . The use of the equipment as an aid to the designer is illustrated by the data presented on the effect of stem angle on pressure loss in globe valves

LOSS OF PRESSURE in a fluid due to friction in valves and other fittings or accessories is frequently based upon broad generalizations. One such generalization is that the pressure loss coefficient (proportional to pressure loss for the same conditions) is 10 for a globe valve. Actually, this coefficient has been found by test to range from 1.8 to 35, depending on the design of the valve. The energy which is converted into heat due to turbulence of the fluid serves no useful purpose. These losses represent large sums of money wasted when pressure losses are higher than necessary.

With these facts in mind, an extensive program of research was undertaken with two primary objectives: (1) to develop a method of testing and of analyzing test results which would permit accurate prediction of pressure losses for valves in service; and (2) to facilitate valve design for low pressure loss by replacing speculation with facts.

This article will concern itself mainly with the former, although some data will be presented on various designs. The method of testing and analysis of results is as applicable for other accessories and fittings as for valves.

Design of Testing Equipment

The fluid chosen for the testing medium was air. Compressor capacity of 4000 cfm of free air against 100 psi pressure is available for testing. This is sufficient to test a valve of 4 in. nominal size at commercial velocities. Valves as large as 10 in. nominal size are satisfactorily tested when the disk is mechanically lifted.

The fluid metering device chosen was the thin plate orifice. Since it was desired to test valves as small as ½ in., two orifice lines were provided. A 1½ in. line, equipped with four orifice plates ranging from 3/16 to 1 in. inside diameter, covers the metering of the air for valves of 2 in. nominal size or smaller. A 4 in. line with three orifice plates ranging from 1 to 3 in. inside diameter gives sufficient coverage for valves of 2½ in. nominal size and larger.

The orifice plates, piping approaching and leaving the orifice, straightening vanes, flanges, and flange pressure taps were all constructed in accordance with American Society of Mechanical Engineers research publications on fluid meters.* Therefore, the coefficients could be taken from the tables in these reports† without further calibration. These coefficients vary slightly with Reynolds' number. However, over the useful range of each orifice, the use of a mean coefficient results in a maximum error of less than 1 per cent.

The testing equipment is shown in Figs. 1 and 2. In Fig. 1 air enters at the extreme right, passing horizontally through either the small orifice (above) or the large orifice (below) to the right of the instrument panel.

The test valves are at the left of the instrument panel. In Fig. 1, the 2 in. valve between the pressure tap hoses is being tested. The pressure taps are in the adjacent pipe one diameter upstream and three diameters downstream. If the downstream tap is closer, all of the loss due to turbulence set up by the valve may not be included. If it is farther downstream, too much pipe loss will be charged to the valve. The same specifications for the necessary run of straight pipe before and after the valve are observed as for the orifices. The flow of air is controlled by throttling valves, either upstream from the orifice or downstream from the valve. This allows the system to be operated at a pressure range of 0 to 100 psi.

Details of the instrument panel are shown in Fig. 2. There are three well type mercury manometers. The one on the right reads orifice pressure differential. The one on the left reads valve pressure loss. The third is used for exploratory work at points within the valve. Three bourdon gages read the upstream pressure at the orifice and at the valve, and the downstream pressure at the valve, in

*Fluid Meters—Their Selection and Installation, 1933, American Society of Mechanical Engineers, New York City.
†Fluid Meters—Their Theory and Application, 1937, American Society of Mechanical Engineers, New York City.

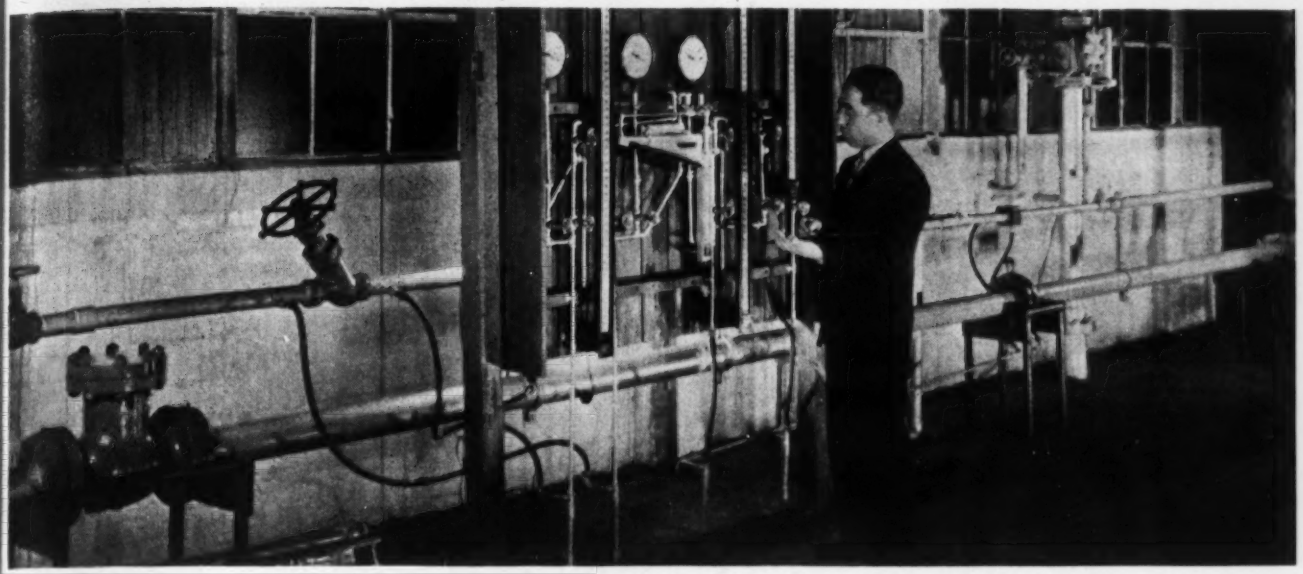


Fig. 1—General view of air test equipment used for testing valves

case the differential exceeds the range of the 60 in. mercury column. Also provided is an inclined oil gage calibrated in inches of water for measuring small pressure drops across the valve. Thermometers in wells upstream from the orifice and the valve complete the equipment.

Simultaneous readings are taken of the pressure differential and upstream temperature and pressure of the air at both the orifice and the valve. These data must then be analyzed to render them useful for prediction of performance under service conditions for various fluids.

Analysis of Test Results

The following analysis is sufficiently complex to permit very general application, thus avoiding the limitations of much published information which is restricted to a specific fluid at a specific temperature or pressure.

The following symbols are used in the development of this analysis:

D—Nominal diameter of pipe or valve, inches;
D_1—Inside diameter of orifice plate, inches;
D_2—Inside diameter of pipe at orifice, inches;
dh—Differential head, feet of fluid;
dP—Differential pressure, psi, orifice or valve;
F—Pressure loss coefficient of valve or fitting;
g—Acceleration of gravity, ft per sec per sec;
K—Flow coefficient for orifice or valve (including velocity of approach);
P—Absolute pressure upstream from orifice or valve, psi;
P_g—Gage pressure upstream from orifice or valve, psi;
P_v—Velocity pressure, psi;
t—Temperature, F (subscript "a" for air);
v—Specific volume of fluid upstream from orifice or valve, cu ft per lb (subscript "a" for air);
V—Velocity of fluid, ft per sec;
V_2—Throat velocity at orifice, ft per sec;
W—Flow rate of fluid, lb per hr;
Y—Expansion factor for compressible fluids;
Z—Coefficient of pressure ratio for compressible fluids.

The equation for computing the flow rate from the orifice data is first derived. For a given orifice in a given pipe the velocity at the throat, V_2, is proportional to $\sqrt{2g(dh)}$ where g is the acceleration of gravity and dh is the differential head.

Since velocities vary throughout the equipment because of changing section and density, it is desirable to express the flow in terms of weight per unit of time. The flow rate in lb per hr, W, is the same at the orifice and at the valve. Velocity and flow rate are related as follows:

$$V_2 = \left(\frac{Wv}{3600}\right)\left(\frac{144 \times 4}{D_2^2}\right) \quad \ldots\ldots [1]$$

where v is the specific volume of the fluid and D_2 is the throat diameter of the orifice.

Also, pressures in psi are more useful than in feet of fluid:

$$dh = 144\ v\ (dP) \quad \ldots\ldots\ldots\ldots [2]$$

Applying a coefficient K to the above proportion and substituting equations [1] and [2], we have:

$$W = 1891\ K\ D_2^2 \sqrt{\frac{dP}{v}}$$

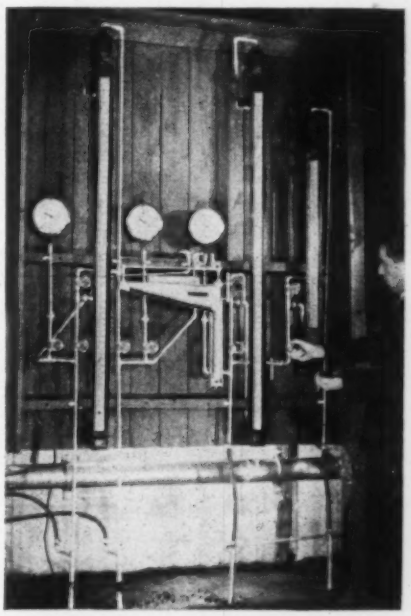
This equation is satisfactory for incompressible fluids. However, with a compressible fluid, as the pressure is reduced in the orifice, the fluid expands, causing lower flow or higher pressure difference than would otherwise be encountered. This necessitates the addition of an expansion factor Y. This factor has been evaluated experimentally for flange tapped orifices in the ASME research report on fluid meters† as follows:

$$Y = 1 - Z\left(\frac{dP}{P}\right)$$

where P is absolute pressure upstream and for air

$$Z = \frac{0.41 - 0.35\ (D_2/D_1)^4}{1.40}$$

Fig. 2—Close-up of instrument panel for air test equipment



It may be seen that Y depends primarily on the ratio of differential pressure to absolute pressure. For a given orifice, D_2/D_1 is constant; therefore, Z is also constant.

The final equations for computing the flow rate from the orifice data are

$$W = 1891\ K\ D_2^2\ Y \sqrt{\frac{dP}{v}} \quad \ldots\ldots [3]$$

and

$$Y = 1 - Z\left(\frac{dP}{P}\right) \quad \ldots\ldots [4]$$

where the K and Z coefficients are taken from experimentally determined data in the above mentioned ASME reference.

The following auxiliary equation is also used to compute the specific volume of the air. It is derived from Boyle's and Charles' Laws:

$$v_a = \frac{459.6 + t_a}{2.70\ P} \quad \ldots\ldots [5]$$

The pressure loss through valves or fittings also in general follows the relation that the pressure drop is proportional to the square of the velocity. Therefore, the same equation slightly modified may be used for valves as for orifices. In the orifice with flange taps the maximum differential pressure is measured and the recovery, which takes place downstream, is not included. In the valve, with pipe taps, the full recovery (if any) is included and the pressure difference is actual pressure loss.

In most valves D_2, the minimum diameter, is not an easily available dimension. Providing that the same diameter is used in analyzing data and in predicting results, any convenient diameter may be used. For most purposes, nominal diameters have proved most satisfactory. Difficulty will be encountered only when extending results to other sizes of valves, since the actual dimensions of the valve are not always proportional to the nominal size.

The evaluation of Y, the expansion factor, for valves is complicated by the dependence of Z upon an indeterminant diameter ratio. Experiments have indicated that the results **are** sufficiently consistent if a constant value of $Z = 0.545$ is used for all valves. This gives good agreement between air and water tests. Of course, since water is virtually incompressible, Y is unity. Further complication of the theory does not appear justified.

The equations for valves then become

$$W = 1891\ K\ D^2\ Y \sqrt{\frac{dP}{v}} \quad \ldots\ldots [6]$$

and

$$Y = 1 - 0.545\ (dP/P) \quad \ldots\ldots [7]$$

The specific volume of the air is determined as for the orifice using equation [5]. All quantities in the above equations are measured or can be computed from test measurements except K, for which equation [6] may be solved. Once K is thus determined for a given valve, the same equations may be used to predict pressure loss for other fluids and conditions of flow.

For this purpose equation [6] is more useful when solved for the pressure loss, dP:

$$dP = \frac{1}{K^2}\left[\frac{W^2 v}{(1891)^2\ D^4\ Y^2}\right] = \frac{P_v}{K^2} \quad \ldots\ldots [8]$$

The term in the brackets is P_v, the velocity pressure of the fluid in psi. This may be seen by converting to terms of head loss and velocity head as follows:

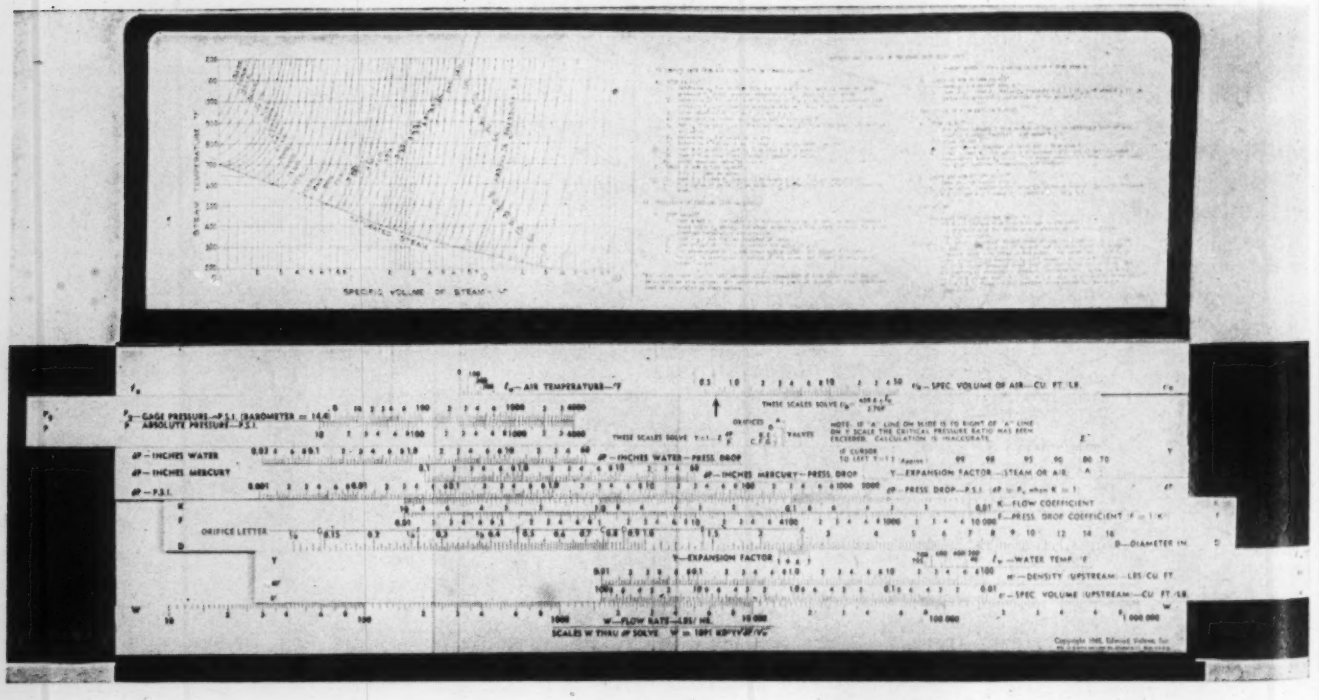
$$dh = \frac{1}{K^2}\left(\frac{V^2}{2g}\right)$$

In equation [8] the flow coefficient K is not as convenient as a pressure loss coefficient F where $F = 1/K^2$ and equation [8] becomes

$$dP = F\ (P_v) = F\left[\frac{W^2 v}{(1891)^2\ D^4 Y^2}\right] \quad \ldots\ldots [9]$$

It may be seen that for constant velocity pressure (same or equivalent flow conditions) the pressure loss is directly proportional to F. Therefore, comparisons of design can best be made by comparing values of F.

Fig. 3—Special slide rule which facilitates analysis of test results and prediction of pressure loss in service


SPECIFIC VOLUME OF STEAM
t_a—AIR TEMPERATURE—°F
v_a—SPEC. VOLUME OF AIR—CU. FT./LB.
P_g—GAGE PRESSURE—P.S.I. (BAROMETER = 14.4)
P ABSOLUTE PRESSURE—P.S.I.
THESE SCALES SOLVE $v_a = \frac{459.6 + t_a}{2.70\ P}$
ORIFICES
VALVES
NOTE: IF 'A' LINE ON SLIDE IS TO RIGHT OF 'A' LINE ON Y SCALE THE CRITICAL PRESSURE RATIO HAS BEEN EXCEEDED. CALCULATION IS INACCURATE.
IF CURSOR TO LEFT Y = 1
dP—INCHES WATER
dP—INCHES MERCURY
dP—P.S.I.
dP—INCHES WATER—PRESS. DROP
dP—INCHES MERCURY—PRESS. DROP
Y—EXPANSION FACTOR—STEAM OR AIR
dP—PRESS. DROP—P.S.I. dP = P_v when K = 1
K—FLOW COEFFICIENT
F—PRESS. DROP COEFFICIENT F = 1/K²
ORIFICE LETTER
D—DIAMETER IN.
Y—EXPANSION FACTOR
t_w—WATER TEMP. °F
w—DENSITY UPSTREAM—LBS./CU. FT.
v—SPEC. VOLUME UPSTREAM—CU. FT./LB.
W—FLOW RATE—LBS./HR.
SCALES W THRU dP SOLVE W = 1891 KD²Y√dP/v

Thousands of tests have been conducted and analyzed by this method. In addition to air tests performed on the described equipment, some of the same valves have been tested with water by the Armour Research Foundation of the Illinois Institute of Technology. Other tests have been performed on steam lines in actual service. Close agreement of results was obtained in all cases.

The value of K or F is practically constant with Reynolds' number for numbers above 50,000. Since lower Reynolds' numbers are seldom encountered where pressure loss is a consideration, variation of the coefficient with Reynolds' number rarely need be considered.

If the pressure drop approaches approximately 45 per cent of the absolute pressure, the velocity of sound is probably reached in the valve or fitting and normal laws of fluid flow cease to apply. Also, if the fluid changes from liquid to gas while passing through the valve, the developed analysis does not apply. These limitations seldom enter into normal pressure loss calculations.

In actual testing of globe and angle stop valves, readings are taken with the disk in various intermediate positions as well as wide open, to determine the throttling curve for the valve. Of course, each position has a different K or F coefficient. Altogether, with check runs, the testing of a single valve usually involves at least 20 separate runs. It was soon discovered that the time necessary to calculate the test results with the standard slide rule was many times greater than the time to perform the test.

Special Slide Rule Developed

In order to reduce this calculating time the special slide rule shown in Fig. 3 was developed by the author. It has the advantage of having the conversion constants built into it. Also, each scale covers the full range of the variable, automatically locating the decimal point.

There are three fixed scales and three slides. The lower group of two fixed scales and two slides solve equation [3] for orifices and [6] for valves. The upper slide and middle fixed scale solve equation [4] for orifices and [7] for valves.

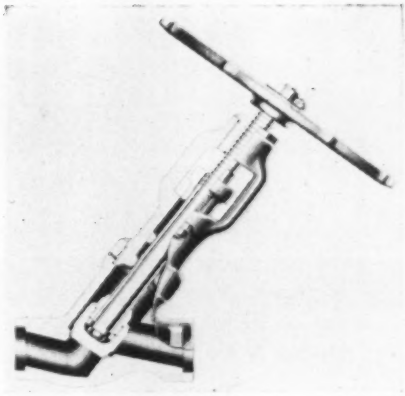


Fig. 4—Valve with 55 deg stem angle, integral seat, welded bonnet, and welding ends

The upper fixed scale and slide solve equation [5]. Since the slide rule can be operated in any sequence, equation [8] can be solved on the same scales as equation [6]. The addition of an auxiliary F scale with the K scale also permits the solution of equation [9]. In addition to the scales for the variables in the above mentioned equations, auxiliary scales are provided for the direct conversion from pressure difference in psi to inches of mercury and inches of water. A direct conversion from gage pressure to absolute pressure is provided, assuming an average barometric pressure. The specific volume of water may be automatically set by setting the temperature on an auxiliary scale. The specific volume of steam is obtained from the graph on the cover.

The orifice constants, K and D_2, could have been laid out as seven special markings on both the K and D scales. However, since KD_2^2 is a constant for each orifice, a single mark for each orifice on the D scale suffices. This is used in conjunction with a K setting of 1, avoiding the use of two special markings for each orifice.

In computing the test data, the values of v and Y are first determined from the upper scales for both the orifice and the valve. The values in the main orifice equation [3] are then set progressively downward from the dP scale to K of unity, to the orifice letter in use, to Y and to v for the orifice, reading finally W, the flow rate, at the bottom. These are alternate cursor and slide operations. From this setting of W the data for the valve are set progressively upward to v and Y for the valve, to nominal diameter, finally reading K or F under the measured pressure loss.

The use of the special slide rule has reduced calculating time for the air tests to less than 25 per cent of that required with a standard slide rule or other calculating aid, as well as reducing the possibility of errors. The slide rule is equally advantageous in predicting pressure losses under service conditions.

Some Test Results

The tests thus far conducted have led to many interesting facts. One of these is the effect of stem angle on the pressure loss in globe valves.

The three valves compared in the accompanying tabulation are all of the forged steel body type and are all of 2 in. nominal size. The seats are identical and the trim sufficiently similar so that results are not affected. The essential difference is in stem angle. The size of the drilled inlet and outlet ports in the body increases slightly as the stem is tilted from 90 deg. Since this increased port size is made possible by the tilted stem the comparison remains a fair one.

Effect of Stem Angle on Pressure Loss

Stem Angle, Deg	Pressure Loss Coefficient, F	Total Deflection Angle, Deg
90	10.1	256
55	3.9	166
45	1.8	102

It will be noted that tilting the stem from 90 deg to 55 deg has reduced the pressure loss 61 per cent. Tilting the stem to 45 deg results in an 82 per cent reduction from the standard 90 deg.

The column on the right in the table is the total deflection angle of the centerline of the passage traversed by the fluid. The great variation of this angle with stem angle explains why the pressure loss varies so markedly with stem angle. It should be kept in mind that these valves were made from forgings. Cast globe valves with 90 deg stems usually have F values well below 10.

A further improvement in design for the 55 deg stem can be obtained by the use of an integral seat. Welding ends also permit superior inlet and outlet ports. Such a valve is illustrated in Fig. 4.

"OPEN FOR DISCUSSION"

We follow here the custom of engineering society meetings in allowing a period for questions, answers, and comment following presentation of a paper. You are invited to contribute your views on published articles, other matters of importance. Address the Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

ALUMINUM GAGES FOR DUCTS

IT WAS A pleasure to read the article on aluminum gages for ductwork on page 77 of the May issue.

By and large, I agree with most of the suggestions made but find myself in complete opposition in connection with the fifth, sixth, and seventh paragraphs, where the article states that a large shop fabricating ducts for commercial use has standardized upon a single gage of aluminum for all its work.

I maintain that this is an absolute mis-statement and contend that the cost to maintain such a standard gage would be prohibitive. This statement is taken from experience, as at one time we were forced to fabricate all of our ductwork with 0.025 in. aluminum simply because other gages were not available at that particular time.

Our experience brings us to the conclusion that 0.025 in. aluminum should not be used for ducts larger than 24 in., 0.032 in. aluminum can be safely utilized for ducts from 25 to 50 in., and 0.040 in. is a quite satisfactory gage for large ducts over 51 in.—W. A. KUECHENBERG, president, R. B. Hayward Co.

REFERRING TO THE article on aluminum gages for ductwork in the May issue, I can't agree with the paragraph regarding the use of 0.025 in. aluminum for all work in a shop, as we find this gage is vulnerable in ducts wider than 24 in.

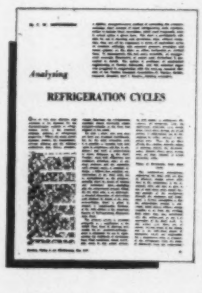
We use 0.025 in. for ducts up to 24 in. wide and 0.032 in. for ducts 25 in. to 48 in. wide, using stiffeners on 4 ft, 0 in. centers; larger ducts can be made of 0.040 in. with bracing to suit.

In another paragraph of the article, it is stated that another shop producing large ventilating ducts reports that ducts up to 4 ft in width can be made from 0.020 in. aluminum by using 24 in. wide coils and making standing seams on 24 in. centers, the standing seams being locked by dimpling with a hand tool. This method requires too much labor, in my opinion.—LOUIS L. NAROWETZ, president, Narowetz Heating & Ventilating Co.

ANALYZING REFRIGERATION CYCLES

IN THE ARTICLE on Analyzing Refrigeration Cycles, published in the May issue, the author has presented in a very understandable way several of the important losses which occur in the practical refrigeration reciprocating compression cycle. Although it is recognized that the losses explained in the cycle are each of small magnitude, the cumulative effect of all of them will materially reduce the overall cycle efficiency.

In addition to being very educational, this article should serve as a warning to the designers and users of the conventional reciprocating ammonia and "Freon" reciprocating cycles that more consideration must be given to the design of piping, valves, ports, controls, as well as to the basic design of the compressor itself, to eliminate or reduce as much as possible these losses.

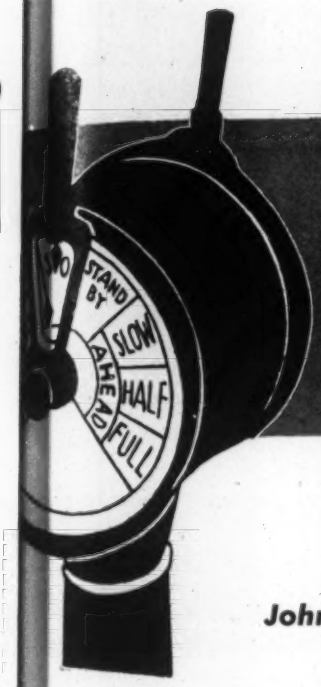


The article further calls to one's attention the necessity of specifying overall cycle performance or rather actual installation performance than to present sales proposals and purchase compressors on indicated horsepowers and compressor displacement.—W. S. BODINUS, district manager, Carrier Corp.

SWIMMING POOL CONDENSATION PROBLEMS

A SOLUTION TO the problem of condensation in connection with indoor swimming pools—discussed by Samuel R. Lewis in the May HPAC—is being attempted by correcting the humidity to provide for the comfort of the occupants as well as to prevent deterioration of the structure, according to E. B. White, of the YMCA Architectural & Engineering Bureau. By means of chemical dehumidification, the relative humidity would be held to 50 per cent. In cooling the space for comfort, the pool water itself would function as an evaporative cooler, very dry air from the dehumidifier being mixed with the saturated recirculated air.

Mr. Lewis expresses doubt of the feasibility of such a scheme, his reasons being that condensation will occur in destructive amounts at a relative humidity considerably dryer than 50 per cent, and the cost of dehumidification by this method—installation, operation, and maintenance—would be "unacceptably high."—ED.



***FIRST-HAND** experience on how designs perform in service, how the equipment is actually operated, and what troubles are encountered were Mr. Clarke's objectives when he (a design engineer by training and profession) shipped on a tanker as junior third assistant engineer. The experience he got was most illuminating, and he reports on some of the piping and other difficulties here, continuing his tale from our previous issue . . . His comments and observations are of interest not only in connection with marine work, for many of them apply to mechanical equipment in plants and buildings as well . . . His seagoing phase completed, the author is now a design engineer with the Standard Oil Co.*

John H. Clarke Writes About "Practical Piping Problems"

Design Engineer Reports on Operating Experience

OUR DEPARTURE FROM Balboa came rather suddenly. The captain was impatient and had no liking for the delay—even less so after the feed pump was supposedly repaired and then burned out again. As soon as the bearings were replaced again, we were to sail; this did not permit us to make any test on the pump to determine whether it would run properly.

Pump Trips Out

We had left Panama about 7:00 a.m., had dropped our pilot, and been under way for not more than half an hour when we had our first emergency for the Balboa-Wellington leg of the voyage. I was on watch (as usual). What happened was this:

On leaving port, no one had thought to open up the steam to the oil bunker heating coils. We were taking oil from the low suctions (about 3 in. above the shell of the ship) and as the speed of the ship increased, the oil cooled rapidly. This immediately overloaded the screw type fuel oil service pump, and the motor tripped out from thermal overload, the oil pressure having built up from the usual 300 psi to 450 psi despite a relief valve that was supposed to be set at 335 psi. We had been having some trouble with these pumps not developing full pressure on the trip from Baltimore, so something of this sort was not too unexpected and was somewhat misleading.

When the first pump had tripped out, the fireman had immediately put on the standby pump, and the chief was called while a check was made to ascertain the cause of the pump tripping out. The first engineer showed up and about that time things were happening fast. The fireman informed us that the oil coming to the boiler room (to the heaters) was 70 F. At about the same moment, the standby fuel oil pump tripped out, so we made a dash to the lower level to restart the first pump for as long as it would keep going. Immediately, we opened all of the oil heating coils wide. There were three coils for each tank. We had a steam chaser line on the pump suction, but the first engineer didn't think it was of any value and wouldn't use it. When the second pump tripped out we had stopped the ship to avoid losing the steam pressure and thus the power for our auxiliary generator. After a short stop we got under way at reduced speed, but it was three or four hours before the oil was sufficiently heated to permit normal power and speed—about 13 or 14 knots, 88-89 rpm, 6000 to 6600 hp. We came out of this scrape all right, although we came nearer to losing the plant than the above might indicate.

As mentioned, we had had some trouble with our fuel pumps coming from Baltimore and it had become increasingly evident that the pump casings had become worn enough so that they were no longer capable of developing the required capacity and pressure. This was complicated by the fact that we could not get sufficient forced draft air to the boilers even when we did get the oil.

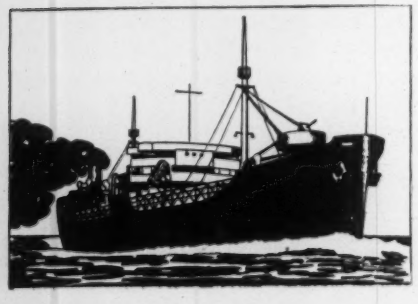
I attribute the lack of air to casing and ductwork leaks in the forced draft system. For this reason, we generally had combustion trouble even in minor emergen-

cies, there being no margin on fuel or air. When we left Baltimore, we were using No. 44 tips on the atomizers (pressure type). At Panama we reduced this size to No. 46, which size was, as a matter of fact, conventionally used on most of these ships.

The rest of our trip to Wellington was without serious incident, although a number of "occurrences" did take place. The afternoon of the day we left Panama the main turbo-generator tripped out without any warning whatsoever. This was very reminiscent of the occasion on the previous ship at Baltimore, when the same thing happened.

This time it was the first engineer who guessed the cause of the loss of excitation on the generator, and went behind the switchboard to check the interlock on the control panel door. He found the door ajar, and discovered that someone had packed a piece of cardboard into the latch recess of the door jamb to prevent it from catching properly. The vibration of the ship had opened the door, thus opening the interlock. Our best guess was that some workman had done this at Panama to avoid the possibility of the 1200 ampere, 2300 volt main panel being energized while he was working in the vicinity. Needless to say, for the rest of the trip, this panel door was wired shut so that it couldn't jar open.

After a short delay of 15 or 20 minutes we got under way again. In the ensuing maneuvering, the water was nearly lost in one boiler. Then the fireman opened the auxiliary feed line and overfilled the boiler to the extent that the surge of cool incoming water dropped the steam pressure and "tied the combustion control system in knots" in its attempt to supply the fuel and air necessary to restore the pressure. On occasions of this sort we laid down a real smoke screen on the horizon. In bringing the turbine up to speed we were still experiencing severe water hammer in the 10 psi gage and 8 psi absolute extraction lines, but still no move was made to drain the lines to prevent this. Apparently our experience at Panama had not been enough.



Expansion Joint Flange Cracks

Several days later the deck steam was turned on so we could use the steam ballast pump in the forward pump room to transfer fresh water aft. In the process, the slip joint which was repaired at Balboa let go. The flange cracked off from the slip for about half the circumference — apparently because of the "cocking action" of the joint due to its inability to absorb both the expansion and the bending resulting from movement of the pipe, and the fact that there was an offset just aft of the slip joint. Only one pipe hanger was provided between the offset and the slip joint, and the piping appeared to pivot slightly about this one hanger. The expansion joint was removed and the copper sleeve or slip was threaded at the flange end and provided with a steel flange. It leaked in increasing amounts for the rest of the trip, but it lasted—I doubt if anyone can explain why. Most of us figured it would do well if it lasted until we got to Wellington.

It was about this time that we crossed the Equator and were treated to the usual initiation. This one consisted mainly of generous applications (some externally and some internally) of a hose, paddles, oil, grease, sawdust, a good dunking in cold water, and a mile long trip through a 20 ft portable canvas tube.

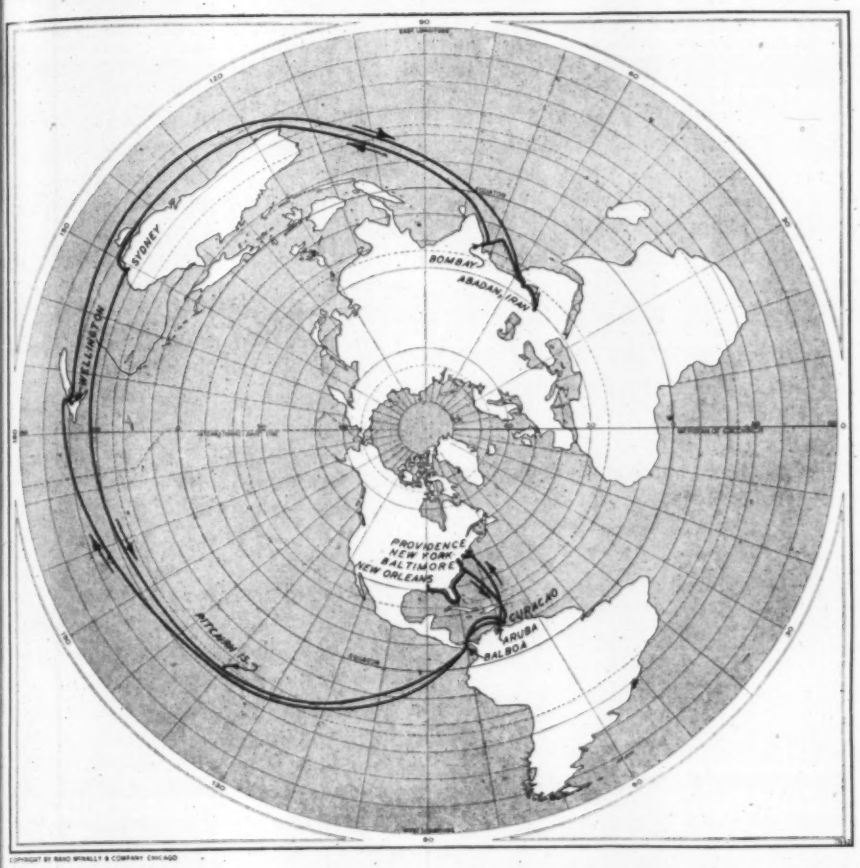
About a week out of Panama, we shifted fuel oil from the forward deep tanks to the bunkers aft. In so doing, the engine room was not notified of the fact, and the cold oil coming into the aft tanks cooled the mixture sufficiently to drop the oil delivered to the heaters in the fire room to 90 F, and to trip the fuel oil pump out from overload. The standby pump was started, and the bunker heating coils were immediately opened. We were forced to reduce speed for awhile, but we managed to avoid a complete stop. This carelessness in keeping the engine room notified regarding such transfers as oil and water from forward to aft continued through the trip and quick action was required on several occasions to avoid real trouble or damage. Usually such notice would be routine. The chief called the attention of the engineers to the necessity of proper notification, but it didn't seem to make any difference.

In transferring the oil, a considerable amount leaked into the forward pump room bilge from a leaking flange on the steam transfer pump. It was necessary to bail most of this out because it became so cold and stiff that it blocked the suctions. This started a general cleanup of the space which consisted of repacking all valves in the space, installing new gages and gage lines for the water and oil pipes (the gage lines had practically rusted out), and repacking the two steam pumps. This work was done by the pumpmen with the help of the first engineer and wipers on day work and the other engineering personnel on overtime.

A Flood

Water was being transferred at the same time as the oil mentioned above. The water was transferred to our double bottom and aft peak tanks. In transferring to the latter, the proper manifold valve was opened but the crossover valve on the tank line was left closed through an oversight. The double bottom tanks were already full and their manifold valves closed. Because of the closed valve to the aft peak tank, the pressure built up to around 125 psi, causing enough leakage through the manifold valves to cause the two forward double bottom tanks (under the machinery space) to overflow through the overflow pipes port and starboard on the generator flat. We had quite a flood to handle before we could get the situation under control. Again, it was lack of coordination and teamwork that caused the trouble.

Because the watch engineer was supposed to spend the major part of his time in the vicinity of the main control station, an oiler was usually sent to make minor adjust-



A lot of practical piping, pumping, and other problems came up during the author's voyage, which is mapped here

ments to the systems, or else the watch engineer made them himself, returning immediately to the control station. It was not advisable to stay and check the tank filling as it progressed. In addition, when the pump in the forward pump room was started for transferring, they had a bad habit of leaving and letting it take care of itself. If anything happened, the only means to stop the pump was to cut off the deck steam in the engine room. The latter could not always be done when other equipment was in operation. There was no direct communication with the forward pump room.

In the above mentioned case, I was responsible for overlooking the valve to be opened, but had someone been checking on the pump the high pressure would have been noticed and a check could have been made of the piping to determine its cause. Our only means of checking in the engine room was to check the tank levels to see how the tanks were filling. On a rolling ship, the fact that it was not filling would not be immediately noticed because these tanks filled very slowly. For the reasons mentioned above, water was overflowed or something else happened about every time we shifted water.

It was my feeling that some one person other than the men on watch should have been assigned to this work, thus permitting a proper check of the piping and procedure. The watch officers are seriously handicapped because of the necessity of remaining near the controls in case of emergencies; otherwise, many odd jobs could be taken care of on watch instead of requiring overtime on the part of some other member of the crew. Of course, on these tankers the first engineer is the maintenance man and does not stand a watch. Consequently, he can and should handle most of the jobs and repair work.

The lube oil pumps on the ship, which were of the screw type and similar to the fuel oil pumps, were showing considerable wear. An orifice is provided in the discharge line of these pumps so as to maintain a minimum of 40 psi on the main turbine governing and trip mechanism. The pressure of the pump in service gradually fell off until it got down to 38 psi. At this point we switched over to the standby pump and were forced to use the latter for the rest of the voyage in order to maintain the proper pressure. The tripping pressure for this system was supposed to be 35 psi. We felt that 38 psi was uncomfortably close to that.

One element of the air ejector for the auxiliary condenser partially plugged up and we changed elements to regain the 2½ in. of vacuum lost thereby. The jet later cleared itself. Of the eight jets on the main and auxiliary ejectors (twin, two stage, ejectors) all had been cleaned at Panama except two, upon which it was impossible to free and unscrew the pipe plugs provided for access to the jets.

Pump Bearings Repaired

Shortly after leaving Panama, the forward feed pump was put into service to see how it would operate. It lasted again for about 15 minutes, with the bearings heating up very rapidly. The pump was stopped and the bearings checked. It was found that on the pump thrust bearings, only three shoes of the one side of the bearing were contacting the thrust collar. The shoes were removed and ground to the proper thickness for uniform bearing and reinstalled. When restarted, the pump ran hot for about an hour and then gradually came down to a reasonably warm temperature.

The bearings on these pumps always ran hot, and the turbine bearings were a particularly serious problem in this respect. On many of these ships the engineers had provided a circulating oil system to these pump and turbine bearings from the main lubricating oil system. This provided good oil for the bearings at all times and helped to keep them cool besides. We had planned to do this at Panama and had made considerable progress along this line but were unable to get the fittings necessary to complete the job. However, had there been more interest in getting the job done, the installation probably could have been made one way or another. As it was, it was put off until too late, so we got very little service out of this pump for the next three months. The pump was used for about a week and then the

aft pump was put into service. The reason for changing pumps was that the vent valve on the forward pump was leaking considerably and this had to be repaired.

We had a regulating valve to maintain fuel oil temperature at the burners but it had been inoperative since before we left Baltimore. Apparently the power element of this self-contained type of valve had failed, and we were maintaining the temperature by means of the bypass valve. One of the oilers coming on duty noticed that the oil temperature was a trifle high, so he screwed down several turns on the bypass valve, thus cutting off most of the steam to the heaters. The sudden drop in oil temperature caused the combustion to fall behind requirements. Although the combustion control system opened the valves wide open, the steam pressure dropped from 440 to 350 psi and we were belching black smoke from the stack. It was necessary to slow the ship down until we could get the oil up to temperature and get up to normal steaming capacity.

As often happened in times like this, water was nearly lost in one boiler during the excitement. This was usually caused by one of two things—either by the feed regulating valve sticking when the water level collapsed as the turbine throttle was closed, or else the fireman backed off too far on the feed pump constant pressure governor adjustment when the ship was slowed down. In the latter case, they often forgot to increase the pressure when the ship was brought up to power and sufficient pressure differential would not be available to feed the boiler at normal capacity.

Many engineers will probably wonder why the governor valve adjustment was moved at all; for their information, we were carrying 75 to 100 psi excess feed pressure at normal power. Unless this pressure was decreased at low power, the feed regulators seemed unable to prevent overfeeding and a consequent high water level in the drums. If the power were increased under this condition, there would be considerable danger of carryover.

In the "Question of the Month" department in Heating, Piping & Air Conditioning, questions from readers and answers by readers are published. Don't miss this practical feature. You are invited to submit questions, and to answer published questions.

Boiler Feed Control

There is another difficulty that enters into the problem of feed control on these boilers. At full power, there is a 13 to 15 psi drop in pressure between the boiler drum and the point on the main steam line where the combustion control system receives its actuating pressure. Consequently, for a 440 psi drum pressure, the combustion control board was set to maintain approximately 427 psi *at full power*. At no load, the boiler drum pressure would also be 427 psi. This increased the feed differential pressure and thus increased the possibility of overfeeding, so it was customary on all of the ships provided with constant pressure feed governors to adjust the pressure during maneuvering. Some of the later ships of this class were provided with excess pressure governors, but even on these ships many of the operating engineers felt that it was desirable to change the excess pressure setting during maneuvering.

It should also be explained that in the marine industry the thermo-hydraulic type of feed regulator, which is actuated by the boiler water level, is used almost exclusively. I am unable to explain this because the actual results in operation for marine service have been poor, to my knowledge. This is no reflection on this type of control for other applications, but in marine service, where a ship is constantly rolling and where there are wide and sudden changes in load during maneuvering, such a control cannot operate properly. During rolling, the feed control valve is moving constantly. Unless the gland packing is tight, the leakage becomes considerable.

If the packing is too tight, the control generator pressure is not sufficient to prevent sticking. Any slight roughness of the valve stem will cause sticking in any case, and on this ship the stems *were* rough and *were* giving trouble, despite having been worked on at Panama. It appeared that at one time or another the valve stems must have frozen to the packing as the result of the gland nuts being turned down too tight.

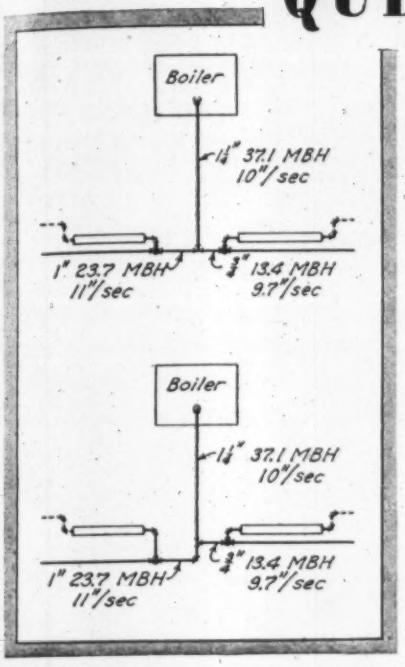
The thermo-hydraulic type of control is also inadequate because, being actuated by the drum water level, the false water level caused when a turbine is brought rapidly up to speed will shut off the feed valve. A "full astern" bell, followed by a "stop," a second "full astern" and a "stop" will practically empty a boiler. A pause at "stop" for a minute will tend to overfill the drum. A bell for full power at this point cannot be adequately answered without danger of carryover and damage to the turbine. This is not a theoretical situation; it happens quite frequently during maneuvering. On a ship it is the water level, not the power of the turbine, that usually determines the rapidity with which full power may be reached, and a bell may be properly answered. Incidentally, this is the main reason that it is essential in maneuvering a ship that the watch engineer be able to observe the boiler water level either directly or by a remote gage.

"Three Element" Control

Considering the above, it would seem that the "three element" type of control, common to the power industry ashore, should be the answer to the marine boiler feed control problem. In this type of control the main actuation is derived from the steam flow by means of a metering orifice, a relay, and a pneumatic control system. A secondary impulse is provided from the boiler water level through a differential pressure element and relay. I do not know of any ship which has ever been provided with a "three element" type of control although this system was described several years ago in a paper on marine boiler control.* The use of this type was suggested to me by a representative of one of the manufacturers who provided boilers for the tankers, and other engineers have since made the same suggestion.

*Boiler Control, by E. G. Bailey and P. S. Dickey, Vol. 50, 1942, Transactions of the Society of Naval Architects and Marine Engineers.

QUESTION OF THE MONTH



In the April issue, "E.L.I." asked if the layout in the lower sketch would give better distribution of water to the radiators than that in the upper

IN ANSWER TO "E. L. I.'s" question about piping connections, published in the April HPAC, the circulation through a gravity hot water system is dependent upon the difference in weight of water in the supply and return lines and of the total friction loss in the entire piping. Circulation through any particular radiator will depend upon the general circulation and also specific conditions in the radiator and method of connecting the supply and return.

The first connection, the bull head tee, will add a considerable loss to the total friction of the system, due to the sudden change of direction of the water and also to the sudden enlargement of the supply lines. These losses will be manifested in turbulent flow, eddying current, and the impact upon the flat surface of the bull head tee. These effects will continue for some distance down the separate branches from the point of the occurrence of the loss. Any radiators that may be connected to the branches in this turbulent region will have a flow whose direction and magnitude will be affected jointly by the general circulation and the turbulent condition existing at that time, at the point of connection.

The foregoing discussion will hold in general for both methods of supplying the branches, but will be greatly aggravated when the water impinges upon the flat surface of the tee, is reflected back upon the incoming particles of water, and eventually flows into the separate branches in a turbulent eddying flow.

The rounded surface of an elbow or the straight through flow of a tee will produce relatively little friction loss as connected in "E. L. I.'s" second sketch.

If the friction loss of the bull head tee were accurately known and included in the design of the system, the system, as shown in the first sketch, will operate but the pipe sizes might be larger than those necessary if the system were piped as shown in the second sketch.

If the bull head tee friction loss were not included in the system design, then insufficient flow would be present to supply adequate heat, due to the friction loss being larger than the value used in the design.

In my opinion, the bull head tee is less objectionable in a forced hot water system, due to the greater head available to produce circulation through the system. If the friction loss were not included in the design for a forced hot water system, greater difficulties might occur because of the lack of the self-regulating property which is present in the gravity system, and it might be necessary to change the pump for a larger size in order to obtain the desired results.

However, I very definitely feel that the use of a fitting in such a manner is decidedly not good practice in any hot water system, because the added expense of an elbow and the small amount of labor necessary to install it are offset many times by the satisfaction of more efficient operation of the system over a period of many years.

The friction loss in any fitting varies very nearly with the square of the velocity, so the added velocity used in a forced circulation hot water system will greatly increase the friction loss in all fittings, in general, and the loss through the bull head tee might reach a prohibitive amount.—J. P. H.

I SHOULD LIKE to submit the following reply to the question by "E. L. I." on page 100 of the April issue, regarding choice of connections between a boiler and two lines.

The bullhead tee shown in his upper diagram is objectionable only because it introduces a considerable amount of eddy current into the flow of the water. The eddy current represents loss of head which could be eliminated only by the use of a Y and two 45 deg ells—a refinement which, in most cases, is not necessary.

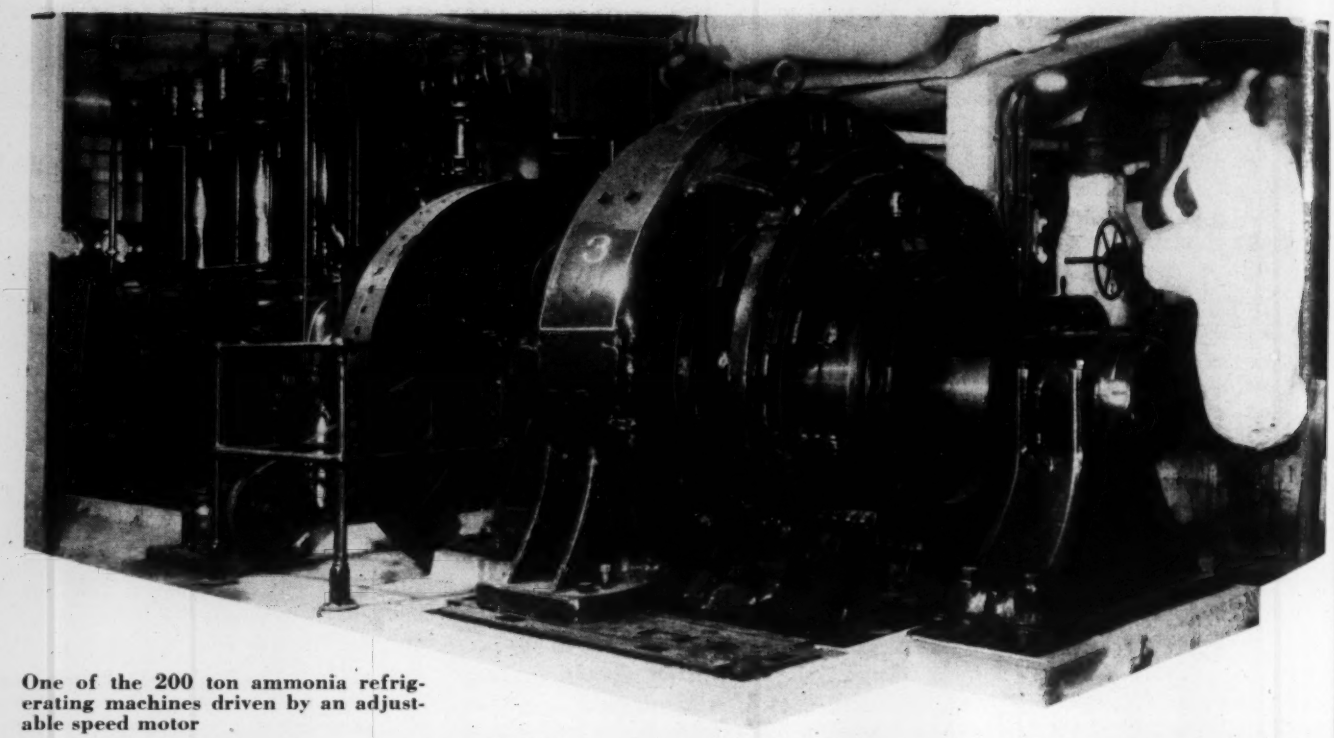
The lower diagram with the tee taken off for the right hand branch and an ell turned to the left hand branch is no better and, if anything, starves the radiators on the right.

With a circulating pump the same considerations apply, but the loss of head with a proper circulator will be too small to worry about.—W. B. S.

HOW MANY MAN-HOURS?

"J. C. B." asks for any information available on the average man-hours required to do the following work: assembling and erecting ductwork, erecting piping, covering piping, connecting compressors and pumps, breaking and patching concrete, ditching, and backfilling. He wants to use this information in connection with general plant changes.

Readers who have figures on these operations are invited to answer this question, or any part of it. "J. C. B." would also be pleased to know of any sources of published data on the matter. Answers to his question, if suitable for publication, will be paid for at regular rates. Address the Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.



One of the 200 ton ammonia refrigerating machines driven by an adjustable speed motor

AIR CONDITIONING the New York Stock Exchange

Donald A. Kepler, Chief Engineer, Shows How It Parallels the Industry's Progress

IN THE EARLY 1800's, the British House of Commons became dissatisfied with the ventilating apparatus that had served the institution for upward of 80 years. They demanded that better equipment and modern methods be installed. But the new fans, like the old ones, were propelled by hand!

When—around 1920—the New York Stock Exchange foresaw the need for building expansion, the building committee cast a deprecatory eye at their 18 yr old air cooling plant and replaced it. But their new cooling coils were exactly like the old ones!

It would be wrong to conclude that no net improvement resulted from either the House of Commons change or the Stock Exchange alteration. On the other hand, these two examples indicate how little progress was made in the field of air conditioning engineering during the periods mentioned. When the Stock Exchange added a new building to the existing structure and rejuvenated its air cooling apparatus completely in 1920, the largest item was the new mechanical refrigerating plant. This was a decidedly more modern system, and it had about twice the capacity of the old absorption plant.

There was a remarkable similarity of circumstances in the planning of the new air cooling installation and the planning of the original job. Rising wages and costs of material threatened to curtail both programs; fitting in the extensive ductwork proved a source of serious interference with structural arrangements in both cases; the two air cooling jobs were designed with very little precedent as a guide, for even as late as 1922 relatively few comfort cooling installations had been attempted.

Little was done to improve artificial air cooling methods from those early days until World War I, and little promotional effort was expended on the general public during that time. However, there were a number of industrial users of "conditioning" equipment — conditioning in the sense that humidity was controlled. The textile trade and the tobacco and baking industries had enjoyed the benefits of conditioning since around 1910. Their problem was to maintain a standard of atmospheric humidity that would best suit their specific production problems. Whether this was accomplished by means of air washers or by various types of direct atomizing devices, the term employed was conditioning.

During World War I, air cooling found a place in the planning of ordnance buildings where the handling of explosives was a serious problem. Under the stimulus of war activity, methods of air cooling improved to the point where comfort cooling could be taken seriously

by movie theater operators whose profits diminished as the temperature rose. The theaters probably did more to promote the cause of comfort cooling than did any other agency, but through the theaters the air conditioning industry suffered a "technical foul." The magic of "20 degrees cooler inside" was short-lived in the box office, for more and more people began to avoid air conditioning of that kind —and any kind. One of the oldest types of air cooling—evaporative cooling—was preened and polished and often sent out to do a theater job that was far beyond its capabilities. This was especially true in New York and other cities along the humid east coast.

Air Cooling a "Must"

When in 1921 the Stock Exchange went ahead with plans for a 24 story addition, which included an annex to the board room, air cooling was a "must." Where formerly cooling had been provided only for the board room and the vault, the new program called for additional systems to take care of the entire floor beneath the board room, the board room annex, and the floor beneath it. Since the existing refrigerating plant was inadequate for such a program, and since absorption plants are notably great space consumers, a mechanical compression plant was selected as a practical answer to the problem.

There were other space problems, too. In order to accommodate the expanded ventilation apparatus, space was allocated on the fifth floor of the new structure immediately adjacent to the hung ceiling over the old board room. Here a completely new system for the board room was laid out near the old supply ductwork. Clearly the old theory that mechanical equipment had to be hidden in the cellar was being displaced in favor of a policy of locating the apparatus near the point of utility. The overall ventilation scheme in the new building called for mechanical ventilation for all areas from the fourth floor down to the fourth basement.

In the old building, some of the basement space was re-assigned, permitting one supply system to be eliminated and several other fan systems to be relocated. When this was done, the fans were replaced by fans of a newer type. The roof fan on the old building was relegated to scavenger duty, handling exhaust from the top floors and some exhaust from the board room. The greater portion of the board room exhaust, however, went to a new exhaust fan on the fifth floor.

The new fans for the old board room were double inlet, single width, in parallel on a single shaft. The supply fan was driven by a 30 hp d-c motor, and the exhaust fan by a 24 hp motor. Cheesecloth filters, similar to those installed with the original job, were provided in the intake chamber.

The board room supply ductwork required extensive rearrangement to conform to the new fan location, since the new supply main entered the ceiling on the north side, whereas formerly two mains entered the ceiling—one in the southwest corner, the other in the northeast corner. Both the board room and the board room annex units were fitted with reversing dampers. These dampers were so arranged that supply air could be delivered to the exhaust outlets near the floor level, and exhaust air could be drawn from the ceiling openings. Exactly how the reversing damper was intended to function is a matter of conjecture, but presumably the idea was this: In the summer, cold air would gravitate to the floor and enervated air could be exhausted near the floor level. In the winter, however, supply air could not be induced to go down since the building stack effect would oppose this motion. Therefore, supplying air at the floor level in the winter would obviate this difficulty and permit its rise to the ceiling by stack action. In this particular application there were two serious objections to the reversing idea which caused it to be abandoned: the incoming air near the floor caused an unbearable draft on those nearby; and reversing the direction of air did a splendid job of cleaning the ducts at the expense of the occupants. Thereafter, the supply was always introduced at the ceiling.

While the reversing damper represented a complication to the duct layout, since the supply and exhaust mains had to run side by side at some point, it proved advantageous when later on it became necessary to recirculate the air. The exhaust main was close at hand.

Two Viewpoints on Humidification

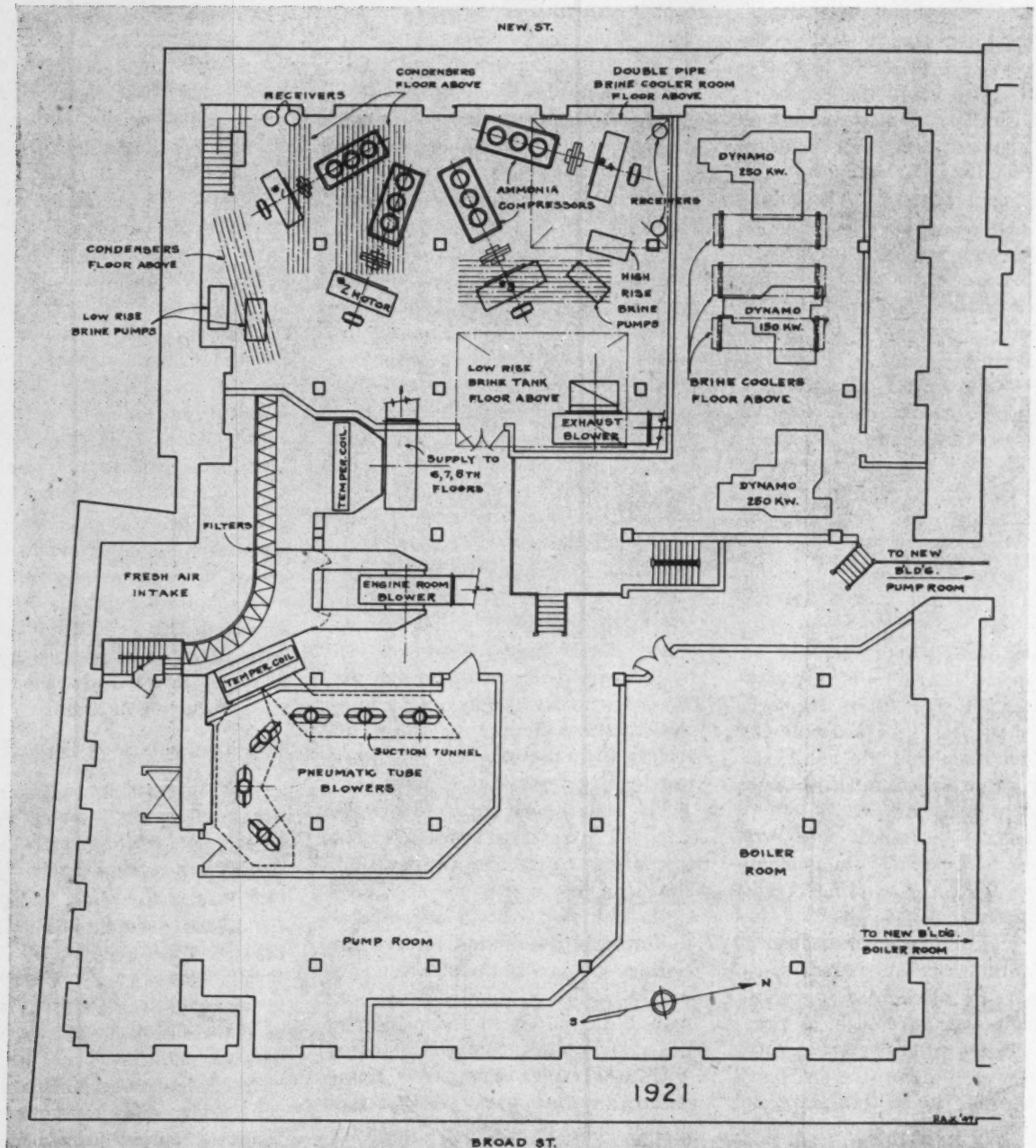
It is interesting to note that no "air moistening" device was provided for winter operation, yet there were several designs of spray humidifiers available at the time. An inspection of old heating and ventilating textbooks reveals that there were two diametrically opposed theories regarding the value of maintaining a prescribed standard of humidity.

In 1911, a prominent figure in the profession minimized the importance of humidification in his explanation, ". . . dry air is hygienically advantageous because of its effect in retarding the development and reducing the vitality of microbes, and also because it retards the decomposition and decay of organic matter. The generally fine physical appearance and evident good health and comfort of the thousands whose school life is spent in the relatively dry air of well-ventilated buildings, and the general absence of complaint from them, must be accepted as evidence of the irrational position assumed by humidity hobbyists."*

At about the same time Carpenter expounded his views, King

THREE HIGH SPOTS of the New York Stock Exchange's air conditioning experiences are its three major air conditioning projects, paralleling the industry's progress. The first is the original system, the introduction of comfort cooling to a large and densely populated market place (described in April). The second is the replacement of the original system, after nearly 20 years of service, with the one now in use (described this month). And the third is the planning of a new system which will include "the best that modern air conditioning has to offer" . . . Mr. Kepler joined the New York Stock Exchange Building Co. as ventilating engineer in 1937, and in 1942 was assigned the duties of chief engineer and those of project engineer for mechanical plant and equipment

*Carpenter, R. C., Heating and Ventilating Buildings, p. 458, 5th edition. John Wiley & Sons, New York (1911).



This unusual arrangement of compressors in the 1921 installation was not altogether a matter of choice; the radial layout was the only way of fitting in the four machines. Two of the air units shown in the 1902 plan are missing. The old supply system that formerly served B, B-1, B-2 has been eliminated and a substitute unit, but one providing air cooling, has been set up in Basement 2. The fan supplying the 6th, 7th, and 8th floors has been assigned the additional job of serving B-2. Pneumatic tube blowers are shown occupying the space where the board room unit was formerly located. Initially, four 90 hp blowers (approximately 7500 cfm each) were necessary to operate the tube system effectively. Some years ago, wooden carriers were substituted for the old rubber carriers and thereafter only two blowers were required. No one knows what happened to the filter cleaning blowers from the 1902 installation

wrote the following: "Proper provision for a desirable degree of moisture in the air supplied to buildings is as necessary, indeed, we may say, more necessary, for the health of its occupants, than the heating of it. . . . One can never feel as comfortable inside a room heated to 70 deg as in the open and balmy outside air when the temperature is at 70 deg. This fact alone shows conclusively that the nearer we can come to maintaining a fixed standard of humidity within a building, the richer will be the conditions of health and comfort."†

Faced with these two conflicting opinions, the designing engineer must have had a difficult choice. It is possible that the Stock Exchange engineers in 1920 were partisans of the Carpenter school.

Both of these men were familiar with air washers and air washer design but they had different conceptions of what constituted winter comfort. King described a spray

†King, A. G., Practical Steam and Hot Water Heating and Ventilating, p. 228, Norman W. Henley Publishing Co., N. Y. (1912).

chamber in which the water is sprayed parallel to the direction of air flow; the excess water is separated from the air by eliminators and is recirculated to the sprays by a pump. This represented a fairly advanced state of washer development. Control was achieved by the use of a preheater and a preheater bypass. He recommended the washer for winter humidification.

Carpenter described a similar air washer, but its chief attribute, according to his claim, was its ability to remove dust from the air. He mentioned also that it may be employed to cool the air during the summer and "add greatly to the comfort of the inmates of the building, but during the winter season, when heating is required, the washing increases the cost of warming the building." Apparently Carpenter's chief objection to the addition of moisture to the air was an operating cost consideration. Neither of these engineers appears to have been overly impressed with the evaporative cooling possibilities; rather they were advocates of the "open window policy" for summer operation.

One of the difficulties present in the Stock Exchange job was the necessity of a secondary refrigerant interposed between the air cooling surface and the low temperature ammonia refrigerating plant. A washer installation would have involved submerged coils, space for which was probably lacking. Possibly the washer idea was considered a roundabout way of doing a job that could be done equally well with the bunker coils, which were the ultimate choice.

Two Brine Circulating Systems

Two brine circulating systems distributed the chilled brine to the individual air units. One system, the high rise system (a closed circuit), supplied the two air units on the fifth floor of the new building; the other, the low rise system (an open system), supplied the two units located in the basement.

In selecting and designing the refrigerating plant, conservative features of plant design were adopted. Not only was the capacity adequate for future expansion, but the drive was selected on the basis of 2 hp per ton. Duplicate brine pumps were installed, and the condensers (double pipe) and evaporators (both double pipe and shell and tube) were sectionalized so that a faulty unit could be isolated. This arrangement proved to have advantages, as the operators discovered on several occasions.

The nominal capacity of the new plant was 750 tons, but operating with a relatively high suction pressure, the plant output could have exceeded 1000 tons had it been needed. Condenser surface was the limiting factor. Three 200 ton and one 150 ton ammonia machines made up the compressor plant. These machines were of the three cylinder, vertical, single acting, enclosed type directly connected to four d-c motors aggregating 1500 hp. Although the local generating plant was still in operation, the compressors were fed from a newly established Edison company service from the street.

Some time before the absorption plant was abandoned, a separate 15 ton, 30 hp ammonia compression plant was installed and connected to the existing brine risers for the drinking water system and the kitchen refrigerators. This was retained.

While the refrigerating equipment for the large plant was arranged so that it could be divided into two separate systems, one for the high rise brine system and the other for the low rise system, the plant operated as a unit with the division valves open. In other words, all condensers and all evaporators were in service with whatever compressors were required. This plan did not prevent the two evaporators from operating at different temperatures and at capacities to suit load conditions.

The air cooling coils were similar to those installed in the old air units, 1¼ in. pipe coils. No eliminators were included in the scheme and on extremely humid days this omission was unhappily brought to the attention of the people on the floor below. The unit had been built on the floor, and the space between the coils and the fan suction was not provided with a drain. Added to this oversight was the unfortunate omission of cold water covering on the drain lines from the condensate pans. These lines were run through a hung ceiling space below the fifth floor, and frequently the formation of condensate on the outside of the lines was sufficient to provide a steady drip through the ceiling.

No Control for Summer Operation

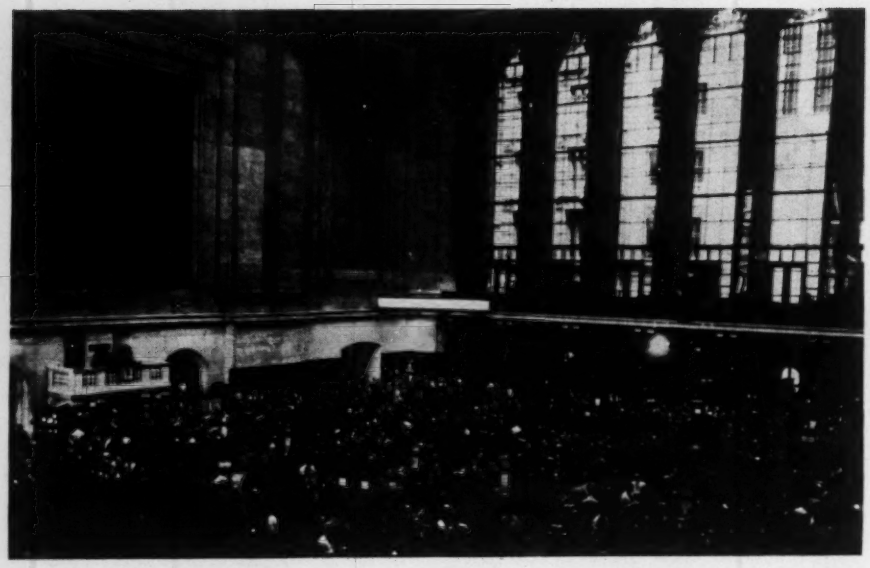
Since no control was provided in the air units for summer operation, the regulation of the supply air temperature rested largely with the refrigeration machine operator. His assignment was further complicated by the fact that there was no brine storage tank, so that a delicate balance between cooling load and machine output had to be maintained. This was done by hand operation of the expansion valves and adjustment of the machine speed.

While this might appear to be a virtually impossible task, the results were surprisingly satisfactory. The d-c motor drive lent itself admirably to this procedure. A chart relating load with output was set up. Since the supply temperature was held at or near 60 deg for most of the summer, and since this was an all-fresh-air load, it was no trick to establish a firm correlation between the outside wet bulb temperature and the refrigeration required. This served as a guide for the plant operator. As a matter of fact, several of the operators after years of experience were able to "fly blind" over the 10 to 3 course with nothing more than the hourly weather reports for assistance.

Brine entered the coils at about 25 to 35 deg and left at about 45. There was seldom any frosting. With the supply temperature held at 60, or several degrees lower, there were few summer complaints.

For years, the increase in the normal occupancy of the board room had been keeping pace with the growth of Stock Exchange activity. By the time the 1921 job had been installed, the occupancy figure reached 1500 and the old apparatus was being severely taxed. The new installation provided for the additional people load by supplying 65,000 cfm as compared with the original 40,000 cfm.

With the complete reorganization of the refrigerating plant that was undertaken at this time, the opera-



Known as the "big board," the New York Stock Exchange trading floor is probably the most densely populated place of business in the city. This view, from the visitor's gallery, shows a part of the throng of 2000 persons actively engaged in the business of the "street." There are perhaps 1000 more persons similarly engaged in adjacent trading areas

tional program also changed. The low rise system had a brine storage tank but the lack of a brine storage tank in the high rise brine system made it necessary to start the machines earlier in the morning so that a storage of refrigeration could be effected in the room itself. The board room load picked up quickly each day about half an hour before trading commenced, and without some storage either in the room or in a brine tank, it was virtually impossible to compensate adequately for the sharp load increase.

Two men were required to start and to operate the refrigerating plant since the equipment occupied two floor levels. The location of the plant was the same as that of the old one, but whereas the old system was more or less on one level with a ceiling height of 28 ft, the space was now divided horizontally, with the condensers and brine coolers resting on an intermediate floor. This arrangement added to the footwork necessary to alter the condenser water flow and to adjust the expansion valves.

Owing to the simplicity of the air units, filters, cooling coils, and heating stacks, general maintenance requirements were few. However, considerable difficulty was encountered in cleaning the cooling coils themselves. Aside from a thin spacer set between the pan and the pipe coils, there was no provision for getting under the coils to clean the pan. The accumulation of dust and dirt after years of operation prevented the free runoff of condensate and accelerated the corrosion of the pipe coils.

Operating Costs Not Favorable

Operating costs for the refrigeration plant did not compare favorably with those of the old absorption plant. Although condenser water costs per ton were much lower, power costs appeared high because they represented a new item on the cost sheet.

Owing to the board room's high internal heat load, it was customary to operate the plant whenever the outside temperature approached 60 deg; this occurred frequently in the spring and fall and sometimes in the winter months. One year in particular, the plant was in operation at least one day in each of the 12 months. Because of the high demand charge imposed by the electric rate schedule, the cost of power for those winter months ran to a large sum. Whether the plant ran one day or several days, the month's power cost amounted to about $325—for perhaps five or six hours of air cooling. One of the advantages of exhaust steam power (or any steam power, for that matter) is apparent wherever operating economy is a primary consideration and where cooling tower water is available. The normal power consumption at the rated output of 750 tons (including power to the brine pumps) was at the rate of approximately 900 kw and the water consumption was about 7200 cu ft per hr. The spring months, with prevailing lower water temperatures, show a somewhat lower water rate than the above figure, with the power consumption remaining nearly constant. During short periods of extremely hot weather, an effort was made to hold the electric demand cost down by increasing the water rate.

The refrigerating plant maintenance was done by the operating personnel during the winter shutdown. Annual internal inspections of all machines were made and bearings were adjusted as required. Scale and oil traps were cleaned, as were water jackets and condensers. However, neither of the brine coolers was cleaned because of their inaccessibility. During the so-called "winter shutdown," one machine was always held in readiness to counter a sudden warm spell.

Change Untimely in One Respect

In one respect, the 1921 Stock Exchange air conditioning change was untimely. It was still too early in the development of the industry to have available the specially-designed equipment (and the ideas) that could even approximately measure up to present day standards. It was a few years later that finned coil dehumidifiers were in common use and recirculated air became generally accepted.

On the basis of summer performance, however, the systems installed at that time were eminently satisfactory; the 60 deg saturated air proved to be very effective, particularly under conditions encountered in the board room.

By the time the Stock Exchange began again to plan additional trading facilities and to expand its air conditioning accordingly, the industry was in a position to encourage new business.

* * * * * *

For information about new products, see Equipment Developments and Recent Trade Literature, regular features appearing each month in Heating, Piping & Air Conditioning.

SAM LEWIS' PAGE

How to Heat Garage Apartments

By Samuel R. Lewis, Consulting Mechanical Engineer

THERE HAS BEEN—and there still is—a decided shortage in places to live. Old stables and garage attics have been impressed into service and the satisfactory and safe heating of such places has been not too easy of accomplishment.

About 20 years ago, following World War I, I bought, in self protection, an old, well-built frame house of three stories and 13 rooms. There was an aristocratic old stable on the alley, having a large haymow, grain bins, etc., in its second story. The outlook from the windows over the neighbors' backyards, and my own, was pleasant. I removed the horse stalls, paved the floor, and thus acquired a three-car garage. I built a brick wall around the interior stair and made an outdoor stair as an additional fire escape.

The haymow and grain bins, well protected with blown-on insulation several inches thick between studs and rafters, developed into a large living room, kitchen-dining room, large master bedroom, two small bedrooms for children, and bathroom.

Underground Hot Water Circuit

My own house is heated by mechanically circulated, thermostatically controlled, hot water, using a bin-fed underfeed stoker. The old boiler was ample in size to take on the job of heating the garage apartment, so I installed an underground hot water circuit in insulated tile to the garage and heated the apartment with a single pipe main run around the garage ceiling. This single pipe main has two scoop fittings to serve the branches to each radiator on the floor above, one to divert the warm water to the radiator flow branch, the other with its scoop in reverse to receive the returning water from the radiator and (by its ejector-like effect) to encourage the two pipe branch circulation.

There are nine radiators and the single pipe is 1¼ in., with ¾ in. branches. The water entering the first radiator undoubtedly is somewhat warmer than that entering the last one, since the water entering the last radiator is a mixture of water that came from the boiler about 200 ft distant with water that has lost some heat in the similarly supplied radiators between the last one and the boiler. There is a separate electric pump in the garage, controlled by a thermostat in the apartment; thus, the apartment is heated independently of the pump and water circulating system in my house. The stoker in my house responds to an aquastat in the boiler water and by this means the heat demands of either the apartment or the house are satisfied independently. Domestic warm water in the house is served by a transfer heater from the boiler water, separate from the pump circuit, and domestic hot water for the garage apartment comes from a separate gas burning heater in the kitchen there.

A few years after this successful plant was in service, I was called to correct some heating difficulties in another similar garage apartment. This apartment is about 50 ft behind a large home.

Fortunately, the main house had a large, efficient boiler and a gravity circulating hot water heating system and it was not difficult to apply here the lessons gained in my own home. We installed radiators, a pump, and a thermostat in the garage apartment and did the same thing in the house, greatly improving the temperature control and economy in the latter, and rendering the garage apartment forever safe against not only a gas accident but also doing away with a fire hazard there.

Would Use Mixing Valve

The only change from the procedures that I adopted for these two plants that I would make, were I to repeat them, would be as follows: I would add in each of the water circulating systems, a water blender or mixing valve, which in response to the thermostat would vary the temperature of the circulated water by taking some hot water from the boiler along with some recirculated water from the radiators, the latter water bypassing the boiler. Thus there would be constant movement of water in each system, with the water temperature varied inversely to the outdoor temperature and the little pumps would operate continuously, since they require an inconsequential amount of electric power.

In the large houses the thermostats in the main first story halls happily do promote a fair average heat distribution, and in the relatively small apartments the thermostats in the living rooms also are acceptable. Had any of the living quarters been complex in plan or occupancy to such an extent that the locations for thermostats became unacceptable, I would have employed outdoor thermostats, each in conjunction with an aquastat in the respective water circuit. Thus the aquastat would have seen to it that the water never would become too cool, while the outdoor thermostat would tend to reduce the water temperature as the weather moderated.

Heating, Piping, and Air Conditioning Featured at Midwest Power Conference

THE SUBJECTS OF heating, piping, and air conditioning were given a good share of the program for the recent Midwest Power Conference in sessions on developments in heating and in air conditioning, and in a session on metallurgy. Brief high-lights of the papers prepared for these sessions—and of a paper on water treatment—are presented here.

HIGH-LIGHTS OF SOME of the many papers given at the 1947 Midwest Power Conference, held at the Palmer House, Chicago, are published here. Of particular interest to HPAC's readers were the sessions on heating (chairman of which was Oliver J. Prentice, C. A. Dunham Co., and president of the Illinois chapter of the ASHVE), the one on air conditioning (under the chairmanship of William Goodman, professor of mechanical engineering at Illinois Institute of Technology, consulting engineer, and a member of HPAC's board of consulting and contributing editors), and the session on metallurgy, chairman of which was Otto Zmeskal, of Illinois Tech.

The conference was sponsored as usual by Illinois Tech, and the conference secretary was Edwin R. Whitehead, 3300 Federal St., Chicago 16.

A copy of the published proceedings will be mailed to all those who registered.

Materials for High Temperature Piping

NEW CONSTRUCTIONS for 900 to 1000 F steam power piping systems are now using chromium molybdenum steels to almost the exclusion of other types, according to J. J. Kanter, Crane Co., in a paper on metallurgical considerations in high temperature steam piping systems. This stands in sharp contrast to the prewar practice of using carbon molybdenum steels for constructions employing temperatures in the range of 750 to 900 F. It was learned several years ago that certain types of carbon molybdenum steels reach the limit of their stability at about 850 F. Prewar practice seems to have pressed the use of the carbon molybdenum type of steel about 50 F beyond the temperature level at which it can be dependably used for welded steam power piping constructions. Hence the new constructions, planned for even higher operating temperatures than had been attempted to any great degree using carbon molybdenum steel, are now specified of chromium molybdenum steels, for which there is abundant evidence of greater high temperature stability, he said.

The success of carbon molybdenum steel as a high temperature piping material was unmarred until about five or six years after the advent of its use around temperatures of 900 F, Mr. Kanter stated. A failure occurred in January 1943 of a welded main steam line in a central power station. This main steam line had been in operation at temperatures somewhat in excess of 900 F for five and a half years, under a pressure of 1300 lb per sq in. Through a chain of circumstances, set off by a disorder developing in the superheater, the line sustained a severe shock, and carbon molybdenum pipe completely ruptured near a weld joining it to a forged carbon molybdenum header. Metallurgical study of the carbon molybdenum pipe rupture established that a zone of segregated graphite had developed at a location corresponding precisely to the extremity of the heat affected zone of the weld.

A recent survey of the type of pipe being specified in various constructions showed a preference for the A-280 type of pipe over the 1 per cent chromium, ½ per cent molybdenum type. The choice of A-280 preponderated, however, largely where operating temperature does not greatly exceed 900 F and the more highly alloyed pipe where temperatures of 950 F and higher are involved. For temperature in the neighborhood of 1000 F, still higher alloy contents are frequently favored, according to Mr. Kanter.

At temperatures of 1000 F and upward, the demands for power piping materials have not as yet assumed any well defined lines, he reported. It appears that further increasing the chromium and molybdenum contents above those now accepted for the 900 to 1000 F range will not satisfactorily adjust the steel to the desired properties, he said. Engineers designing high pressure piping systems for 1000 F and higher temperatures seek to accomplish this end without increasing weight appreciably above that employed in the current 900 to 1000 F installations. The allowable stresses for the chromium molybdenum steels fall off rather rapidly above 950 F and it becomes necessary to turn attention to other and perhaps much less familiar alloy steels to correct this difficulty to a significant degree as far as weight

of section is concerned. Some engineers advocate the use of steels of the 18 per cent chromium, 8 per cent nickel stainless type for above 1000 F. Such austenitic steels are accorded considerably higher stresses by the ASME Boiler Code than any of the low alloy, ferritic steels currently standardized. The problem of coping with thermal expansion is intensified by their roughly 50 per cent greater expansivity over that for ferritic alloy steels. Due to lower thermal conductivity, coupled with greater expansivity, the problems of thermal stress and thermal shock are introduced to a degree of considerably greater consequence than with the ferritic steels. Considerable promise that the problems of piping construction for temperatures up to 1050 F may be worked out on a practical basis in terms of low alloy ferritic steels is afforded by the combination of molybdenum and vanadium as the principal alloying ingredients, he remarked.

In view of the apparent incentive to achieve further economies in the generation of steam power through utilization of higher temperature, one cannot conclude that the metallurgy of the piping system will long remain static upon the current choice of materials. Research upon the high temperature properties of materials may be expected to make possible appreciable further advances in the temperatures at which steam may be economically handled. Currently, the piping materials picture is in a rapid state of flux, indicative of drastic further changes within the next few years, Mr. Kanter concluded.

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Demineralized Water —the Process

EARLY IN 1930—said Lyle B. Porter, Illinois Water Treatment Co., in his paper on demineralized water—while working on organic zeolites in an attempt to develop more stable compounds, it was noted that these materials had definite hydrogen exchange properties. This meant that instead of exchanging the calcium and magnesium in the water for sodium in the zeolite, all cations, including sodium, could now be exchanged for hydrogen in the zeolite forming the corresponding acid in the effluent water; HCl for all the chlorides present; H_2SO_4 for all the sulfates; and H_2CO_3 for all of the carbonates or bicarbonates present in the original water. The carbonic acid immediately breaks down into CO_2 and H_2O. The acids could then be neutralized by the addition of caustic or soda ash or, better, blended with sufficient raw or sodium zeolite water to just neutralize the acids present. This process produces a water similar to and often superior to lime or lime-soda treated water. This process is referred to as de-alkalization.

A new resin has recently been developed that is specific in its reaction toward the bicarbonates in water but only partially converts the more tightly bound sulfates and chlorides. This resin is very economical on acid consumption, operating at practically 100 per cent efficiency. When operating as the first unit and in series with a sodium exchange unit on low sulfate and chloride waters, a water of low total dissolved solids and completely free of encrusting solids can be economically produced. Any desired alkalinity of treated water can be maintained by blending raw water in the line between the units, according to Mr. Porter.

Has Become Very Popular

This type of equipment has become very popular for the treatment of boiler water—particularly for the smaller boiler plant operating at low or moderate pressures, he said.

A short time after the development of the carbonaceous zeolites, he continued, it was found that certain polyhydric phenol formaldehyde resins would exhibit the base exchange phenomenon, operating on either the sodium or hydrogen cycle. These resins had certain advantages over any of the previously announced exchangers both in stability and completeness of reaction.

Next, all attention was directed toward the development of a material that would remove the acids formed by the hydrogen exchange previously noted, and thus the acid adsorbing resins were developed, Mr. Porter said. These resins selectively but reversibly adsorb the acid molecule. When the capacity of the resin becomes saturated or exhausted, the acid is removed and the resin returned to its original state by regeneration with an alkali such as caustic soda, soda ash, or ammonia.

It is very apparent that the development of the resinous exchangers gave the water treatment industry a revolutionary tool for the production of water altogether free of dissolved solids—water that is equivalent to and very often superior to single distilled water. This process of two-step treatment is commonly referred to as de-ionizing or demineralizing.

Time doesn't permit a detailed discussion of the design and engineering features of a de-ionizing unit, Mr. Porter remarked. Suffice it to say an installation consists of cylindrical pressure tanks to house the resins, adequately valved to permit control of the various phases of operation and accessories such as regenerant tanks, meters, etc. All materials used in the construction must be resistant to the corrosive action of the dilute acids encountered, not only to prevent destruction of the equipment but also to protect the purity of the treated water. Freedom from corrosion is obtained by fabrication of materials inherently resistant to the acids or by lining steel with acid-proof materials such as plastic or rubber.

Heat Pump Cycle Using a Ground Coil

UNTIL VERY RECENTLY, little thought was given to the possibility of utilizing the energy stored in the ground as a source of heat supply for the heat pump, according to R. A. Budenholzer, Armour Research Foundation of Illinois Institute of Technology. However, during the past year the Armour Research Foundation has been studying this problem, and the results indicate that the ground provides a promising source of heat supply for small units designed for residential heating and cooling. It is well suited for this purpose because the earth furnishes a comparatively stable low temperature source of heat which is universally available and which is not appreciably affected by sudden variations in local weather conditions.

These studies have revealed the fact that a ¾ in. OD or larger coil buried 2 or 3 ft below the average frost line will serve satisfactorily, provided a sufficient length of coil and proper spacing are employed to prevent excessively low refrigerant temperatures inside the coil during the heating season. The study has indicated that when using this size coil in a soil having a thermal conductivity around 1 Btu per sq ft per hr per F per in. of thickness, the following rule will hold approximately, he said. The temperature of the evaporating refrigerant inside the coil will assume an average value for the heating season of approximately 1 F below the surrounding uniform soil temperature for every Btu withdrawn per hr per linear ft of coil exposed to the ground. In other words, if the average load on a certain coil buried at a depth of 6 ft is 30 Btu per linear ft per hr, and if the average temperature of the soil at this depth throughout the heating season is 50 F, the average temperature of the evaporating refrigerant during the heating season would be approximately 50 minus 30, or 20 F.

It should be pointed out that this rule is only approximate and that it applies only to the soil conditions mentioned above, which are essentially those existing in the Chicago area. It is based on a mathematical analysis and does not take into account the effects of freezing of the moisture in the earth surrounding the coil and other factors difficult to evaluate quantitatively. (Later studies have indicated that the effect of freezing of the moisture in the earth may actually be of controlling importance.) However, since these effects will tend to decrease the drop in temperature of the ground coil, the rule should be on the conservative side.

During the cooling season when heat is rejected from the coil into the earth, the same rule may be applied in reverse. Here again the rule will only be approximate because the effects of rainfall seeping through the soil cannot be evaluated accurately by the mathematical procedure employed. However, it is believed that the accuracy obtained will be within the limits normally required to establish the performance of a given unit with sufficient accuracy for most practical purposes, and that the results will be on the conservative side, he remarked.

In order to present a realistic picture of the costs of operation which can be expected of heat pump installations compared to other means of heating, Mr. Budenholzer presented the accompanying table, which shows the sum which would have to be paid for electrical power, in cents per kwhr, in order to be equivalent economically to other means of heating. The table shows how this cost varies with evaporator temperature, condenser temperature, and overall isentropic motor compressor efficiency. In making the computations, values of the low and high side pressure drop were taken as equal to 8 and 5 lb per sq in, respectively. These are based on actual values obtained using a 3 hp experimental unit. This unit utilized the ground as a source of heat and was actually operated as a heating unit for a continuous period of 863 hr. During this operation the low side pressure drop averaged 8 lb per sq in. and never exceeded 9 lb per sq in. The high side pressure drop never exceeded 5 lb per sq in.

It is believed that an overall isentropic motor compressor efficiency greater than 60 per cent is not commercially feasible at the present stage. Hence, taking this as the efficiency and assuming mod-

Table showing value which could be paid for electricity in order to compete with coal, oil or gas for various evaporator and condenser temperatures, and various overall isentropic motor compressor efficiencies. Assumed low side pressure drop, 8 lb per sq in. Assumed high side pressure drop, 5 lb per sq in. Based on the following fuel prices: coal 14,800 Btu per lb, $11.69 per ton, 50% furnace efficiency; No. 3 oil, 137,500 Btu per gal, 9c per gal, 65% furnace efficiency; gas, 7c per therm (100,000 Btu), 70% furnace efficiency.

Overall isentropic motor compressor efficiency	Evaporator temperature F	Equivalent Price of Electrical Energy, Cents per Kwhr — Condenser Temperature, 110 F				Condenser Temperature, 120 F			
		COP	Coal	Oil	Gas	COP	Coal	Oil	Gas
0.50	10	2.65	0.69	0.90	0.90	2.54	0.68	0.86	0.86
	20	2.94	0.80	1.02	1.02	2.81	0.76	0.96	0.96
	30	3.31	0.89	1.13	1.13	3.14	0.84	1.08	1.08
	40	3.77	1.01	1.28	1.28	3.54	0.95	1.22	1.22
0.60	10	2.97	0.80	1.02	1.02	2.84	0.77	0.97	0.97
	20	3.32	0.89	1.14	1.14	3.16	0.85	1.08	1.08
	30	3.77	1.02	1.29	1.29	3.54	0.96	1.22	1.22
	40	4.32	1.17	1.49	1.49	4.05	1.09	1.39	1.39
0.70	10	3.30	0.89	1.13	1.13	3.16	0.85	1.08	1.08
	20	3.72	1.01	1.27	1.27	3.52	0.95	1.22	1.22
	30	4.24	1.14	1.45	1.45	4.00	1.07	1.38	1.38
	40	4.88	1.32	1.68	1.68	4.55	1.23	1.57	1.57

erate evaporator temperatures in the neighborhood of 20 to 40 F, it is evident that reasonable coefficients to be expected will lie roughly between 3.1 and 4.3. This means that to compete on a purely economic basis, electrical energy for heat pump installations would have to be available at roughly 0.85 to 1.5 cents per kwhr, depending on the locality and climatic conditions. However, he said, the heat pump has so many advantages, such as summer cooling, lack of fuel storage, ease of operation, and cleanliness that it should be competitive with other forms of heating even though the cost of electrical energy is considerably higher than the figures quoted. Certainly it would appear to have prospects of widespread application in those localities where electrical energy is inexpensive and where climatic conditions are moderate.

Annual Hours of Operation of Air Conditioning Systems

IN HIS PAPER on compressors for air conditioning, A. B. Newton, Airtemp Div., Chrysler Corp., presented some data on usage of various types of installations. Air conditioning compressors of the larger sizes, say from 15 to 100 hp, are generally installed in so-called central station jobs; the compressor or compressors each cool one or more coils over which air is circulated to the conditioned spaces.

These compressors, if equipped with capacity unloaders, are infrequently started and stopped. Without unloaders reduced voltage and manual starting is more often required. However, the nature of these installations is such that an adequate polyphase power supply is usually available. The most frequent exception to this ready availability of power is in the residential retail shopping centers where the larger compressors are used, for example, in theaters and sometimes in bowling alleys.

There is at present an inconclusive amount of data regarding hours of annual operation for this class of installation, but the accompanying table will give approximations until more complete data are available, he said. It should be noted that this class of installation inherently carries sufficient usage to make a desirable load.

Air conditioning compressors of the medium sizes, in the range of from 2 to 10 hp, probably have by far the greatest future use both in number of installations and in horsepower, he stated, yet it may be in this classification that the greatest additional power supply services are required. The most popular equipment is the 2, 3 and the 5 hp unitary air conditioner. Indeed, use of these units in multiple on larger and larger jobs is increasing literally by leaps and bounds. For example, several large department store and office building jobs have recently been installed with between 60 and 100 units of 5 hp each. In these large unitary jobs yearly operation about as indicated in the above-mentioned table may be expected.

However, this range of sizes is also used in smaller buildings which require from one up to nine or 10 units. In downtown or industrial districts nearly all these units are installed on polyphase service. In outlying districts such as residential business centers it is often more convenient to install 230 volt single phase units, particularly if the 2 or 3 hp size is to be used.

The second table gives approximate hours of usage for air conditioning compressors in medium size jobs. These figures are from limited data, and anyone who can contribute additional data will perform a real service to the industry by doing so.

The room air conditioner is the smallest compression type equipment made in large quantity and has its own special power problems. The range of sizes is from ½ to 1½ hp, with the ¾ hp window unit by far the most popular.

In this size the compressor and fan together are usually limited to 1300 to 1400 watts at conditions generally encountered. However, since these units go into residences, offices, hospitals, hotel rooms, and other similar places and are installed without permanent wiring, they usually are plugged into 115 volt single phase supply. Almost without exception they are manually started and stopped, and seldom more than twice a day.

In spite of the thousands of room air conditioners in use, less data is available as to annual usage than with other sizes and types of air conditioning apparatus. Yet perhaps such data would be most useful to those interested in generation and distribution of power. The third table shows the best available estimate we have of hours of use of this class of equipment.

Usage in Medium Size and Unitary Installations

Type of Installation	Range of Hp	Typical Annual Hours of Cooling	Typical Annual Hours for Heat Pump
Theater	5- 75	1800-3600	
Specialty store	3- 50	1200-2000	
Office suite	2- 15	1000-1800	
Professional office	2- 10	800-2000	
Single apartment	2- 5	800-1600	2500-4000
Residence	2- 6	800-1600	2500-4500
Hospitals	2-100	1200-3000	

Usage in Central Station Installations

Type of Installation	Range of Hp	Typical Annual Hours Operation
Theater	10 to 100	1500-3000
Department store	10 to 300	2000-4000
Industrial comfort	10 up	1500-5000
Industrial process	10 to 75	2500-8700
Restaurant	10 to 75	1000-2500
Office building	10 to 1500	1200-4000
Hotel rooms	10-500	1500-3500

Usage of Room Air Conditioners

Type of Installation	Typical Annual Hours of Use
Private office	600-1500
Hospital	1200-2500
Professional office	800-1500
Hotel rooms	1200-3000
Residence	900-1800

Air Conditioning Costs Have Increased

AIR CONDITIONING costs have increased just as they have in practically all industries and for practically the same causes, said John R. Hertzler, York Corp., in his paper. The air conditioning equipment manufacturer has raised wages and salaries of employees from 55 to 60 per cent over 1941 base rates. Subcomponent and material prices are up an aggregate 25 per cent. While total costs of labor and material are increased about 35 per cent over 1941, prices of equipment have advanced about 25 per cent.

The overall cost of the complete system is about 60 to 65 per cent more than prewar costs, he said. Mechanical contractors advise that the hourly rate and material costs are only a small part of the story. The cost increase rests in the productivity or lack of productivity of the individual workmen.

You can expect to see an increased usage of packaged air conditioning products and a trend toward multiple unit installations, Mr. Hertzler predicted, because the American economic system so reacts to the pendulum effect of costs to reflect changes such as those which have come to light in our industry.

Postwar air conditioning advances must be considered as negligible when compared with the potential development of air conditioning techniques known, but little used, prior to the war, according to Mr. Hertzler. There are a number of refinements which have not yet been developed to the full extent of their possibilities, he said, including electrostatic air cleaners, activated carbon or other odor adsorbers, germicidal lamps, radiant or panel heating, chemical dehumidification, the heat pump, controls, air diffusing devices, valves, and specialties.

Ceiling Panels Heated with Air

IN HIS PAPER on panel heating with air, H. F. Randolph, International Heater Co., said that the ceiling has been used as the heating panel for the following reasons:

1) The space that may be made available within or under a floor is rather limited, resulting in a high friction loss and a rather exhorbitant electrical cost for air circulation.

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2) A floor temperature cannot exceed 85 F without causing discomfort to the feet. A ceiling panel can be heated to 115 F without the occupant becoming conscious of the source of heat. Therefore, a ceiling panel can introduce at least 50 per cent more heat per unit of surface than a floor panel. Many times a ceiling panel is adequate to satisfy the heat loss of a room where a floor panel is not.

3) When the source of heat in a room is low, as in a floor, more convection currents are established than when the heat source is high. With a ceiling panel, 50 per cent more heat is introduced by radiation than from a floor panel.

4) A ceiling is the only unobstructed surface in a room, being unaffected by doors, windows, draperies, pictures, furniture, or floor coverings.

5) A floor panel is generally constructed of a concrete slab several inches in thickness which is slow to heat and slow to cool, whereas a ceiling panel is generally constructed of a ¾ in. thickness of lath and plaster, the thermal storage capacity of which is so slight it can be intermittently controlled to follow outdoor temperature changes rapidly with no noticeable lag.

Various types of construction have been used for warm air ceiling panels but limitations are imposed by the fire underwriters so that even though low temperature air is employed, no materials having a fire rating classification above 20 are approved, he said. The air used for heating is in a closed system, none of which is projected into the living quarters. The air is conveyed from the heater to the ceiling panels by conventional ductwork with a warm air supply to the panel of each room but with generally only one return from each story of the building. The old fashioned gravity furnace installation often had only one cold air return back to the furnace so that an objectionable draft was created as all the air on the floor swept to that one point. With panel heat this is not a consideration as the air travel is all above the ceiling. The use of a common return with individual supplies reduces cost of both labor and material yet affords a means of regulating heat in each room. The warm air supplies are carried between the studs, between the joists, or in the attic and when exposed to cold surfaces they are insulated.

Directly under and to the joists a partition of gypsum board is attached and below this is suspended a metal lath and plaster ceiling. Within this space the air is circulated, directed by galvanized strips in such a way that the air covers the entire ceiling. Where possible the baffling is so arranged that the warmest air is conducted over that portion of the ceiling adjacent to the exposed walls.

The maximum air temperature used is 140 F at the discharge of the heater so that entering the panels it is of the order of 130 F

and leaving the panels about 85 F. The quantity of heat introduced in a given room is controlled by the volume of air to its individual panel.

Compared with forced warm air heating the temperature drop of the air is much less so that about a 50 per cent greater volume of air must be handled. However, velocities can be higher because the occupants are not affected by air movement, and as there are no registers or openings into the rooms the noise level due to this is not a consideration.

While most installations of warm air panel heating so far have used direct fired heaters, two building plans are now being developed which will use hot water through exchangers, Mr. Randolph concluded. One of these is a central school in which it is planned to use panel heating for all classrooms and reduce the tempered fresh air to 50 per cent of current legal requirements as an experiment.

Advantages of Radiant Baseboards

SPEAKING OF TESTS with radiant baseboards at the University of Illinois, Prof. Warren S. Harris said that this system provides warmer floors, gives a very small difference between floor and ceiling temperature, is very convenient in being both inconspicuous and in not interfering with furniture placement, and is outstanding in cleanliness. The unit tested is a hollow cast iron baseboard, placed at the bottom of the outside walls in a room, and painted to match the wood trim at the base of the other walls. Hot water in the baseboard is supplied from a conventional heating boiler through concealed pipes.

By concentrating heating effect along the base of the coldest wall, the radiant baseboard produces warm floors.

Comparing the radiant baseboards with conventional small tube radiators, on the basis of tests conducted with each in the IBR research home at the university, Professor Harris said:

Drafts were not experienced with either radiant baseboards or small tube radiators.

Radiant baseboards produced warmer floors and cooler ceilings than did the small tube radiators.

From the 60 in. level to the floor, the inside surfaces of the walls along which the radiant baseboard was installed were warmer than the room air at the 30 in. level of the thermostat, whereas these surfaces were cooler than the room air when the small tube radiators were used.

The radiant baseboard was clean in operation.

The radiant baseboard blended with the wood trim of the room in appearance and did not interfere with placement of furniture in the room.

Fuel consumption was essentially the same with both methods.

Materials for Boiler Feed Pump Construction

THERE are no ironclad rules for avoiding trouble with carbon steel parts of boiler feed pumps, said H. L. Ross, Allis-Chalmers Mfg. Co., in discussing materials for pump construction. But in general, he said, it is advisable to keep the pH value above 9.0 or 9.5 by recirculation, or by the addition of caustic and to eliminate sodium sulphite. It may also be helpful to alternate the pumps in service—the theory being that the idle pump will build up a protective film, which causes some measure of protection after it is in operation.

Built Up with 18-8

Existing pumps may have the fits between stages built up with 18-8 or other stainless material and may even have the volutes lined with stainless steel, although this usually involves sending the pump back to the factory. The use of a coating of bakelite lacquer has been reported; this consists of a baked on coating only 0.0003 in. thick which was practically unattacked after a 500 hr accelerated test. However, there may be difficulty in applying this coating to closely machined surfaces and keeping it intact during assembly.

5 Per Cent Chromium Steel

A more logical and positive solution—according to Mr. Ross—to the problem is the use of the proper materials, which will take care of practically any feedwater condition. In general, it appears that a 5 per cent or better chromium steel is practically immune to attack, but there are other factors which may make the selection of another material a better one for the particular installation.

Prevention of Troubles

The prevention of troubles on new installations seems to lie particularly in the direction of materials which will stand any normal feedwater conditions, he concluded. It is extremely difficult to control the feedwater, particularly as to pH value and oxygen content so as to definitely assure a favorable feedwater to the pumps. Furthermore, of course, all feedwater control is pointed toward maintaining the best condition at the boilers. It is obviously quite impossible for the pump manufacturer to guarantee the pump materials to be suitable for the feedwater handled in a particular installation. General practice is to guarantee that the materials will be furnished in accordance with the contract specifications with the user taking the responsibility for the feedwater condition, and for the selection of the materials.

PLANNING TO AIR CONDITION?

Don't Neglect Humidity Control

AT FIRST THOUGHT, comfort cooling might seem simply to be the reverse of winter heating—that is, it might seem to be enough to cool the air entering a building to the desired temperature. But humidity prevents this simple solution.

If we should cool summer air at 95 F dry bulb and 75 F wet bulb (40 per cent relative humidity) to 70 F, without removing any moisture, we would have air almost 90 per cent saturated with moisture, an atmosphere so damp and clammy as to intensify the discomfort.

To bring the air to a comfortable temperature and relative humidity we first must squeeze out the surplus moisture. This we condense out by cooling the air to approximately 55 F—a temperature much lower than required in the building. This air must then be reheated to a normal room temperature *by some means* before coming in contact with the occupants. The methods of accomplishing these results are as follows:

1) Under normal conditions of sensible (dry heat) and latent (moisture heat) requirements with outside conditions of 95 F dry bulb and 78 F wet bulb, the conditioned air should pick up enough heat from the room so that the resulting room conditions will be 80 F dry bulb and 50 per cent relative humidity. This, of course, is based upon the air conditioning equipment being of sufficient capacity to accomplish these results, or to have excess capacity with automatic temperature control.

2) The cold air may be reheated a few degrees with steam coils or electric heaters after being reduced to whatever temperature may be required in order to remove the moisture.

3) The air from the conditioned room may be returned to a central plant, where it is mixed with the incoming fresh air, either before or after the cooling coils, or only a portion of the returned air made to bypass the cooling coils, as may be desired.

Design Conditions

In designing a comfort air conditioning system, definite design conditions and factors should be considered. These are:

1) The condition of the outside air is assumed [in Philadelphia] to be 95 F dry bulb and 78 F wet bulb (47 per cent relative humidity).

2) The condition of the inside air is to be maintained at 80 F dry bulb and 66.7 F wet bulb (50 per cent relative humidity) under the external conditions specified. *Note:* The capacity of the installation in every respect should be ample to maintain the inside design conditions under the outside temperature conditions above specified.

3) Outside fresh air in sufficient quantity must be supplied to adequately ventilate the space and to maintain a proper breathing level for the occupants. This air, theoretically, must be cooled and dehumidified from outside temperature conditions to the inside temperature conditions.

4) Each occupant of an office emits approximately 490 Btu per hr of heat; 225 Btu of this total consists of sensible heat made up of radiant and conducted heat, and 265 Btu of latent heat in the form of water vapor. This amount of latent heat corresponds to 1787 grains of moisture or 0.255 lb per hr of water vapor liberated in the room per person. A sufficient quantity of air, accurately conditioned as to both dry and wet bulb temperatures, must be liberated within the room to absorb this heat.

5) Heat enters the space to be conditioned by conduction through the building walls, roof, doors, and windows, and by sun rays entering through the glass directly exposed to such rays. This constitutes sensible heat. The conditioned air liberated within the room must first be cooled to a sufficiently low dry bulb temperature in order that the absorption of this internal sensible heat will raise its temperature to 80 deg.

6) The electric lights in the space to be conditioned give off sensible heat. Every 1000 watts of lighting will give off 3412 Btu in heat. Since 1 ton of refrigeration is the equivalent absorption of 12,000 Btu per hr of heat, for every 3.5 kw of lighting load of 1 hr duration, 1 ton of refrigeration will be required. Again, the conditioned air entering this space must be of the proper reduced dry bulb temperature so that it will absorb this heat with a resulting final temperature of 80 F dry bulb.

7) As a composite requirement, the total amount of air *admitted to the conditioned space* must first have been reduced to a definite dry bulb and an equally definite wet bulb temperature, resulting in the ability of the air to absorb, for example, a total heat load consisting of 85 per cent sensible heat and 15

This Report on Planned Air Conditioning for Office Buildings has been prepared by the subcommittee on air conditioning of the committee on education and research of the Building Owners' and Managers' Association of Philadelphia.

The report was presented by C. Robert Cheyney, operating manager of the Fidelity-Philadelphia Trust building, at the annual meeting of the Middle Atlantic Conference of Building Owners and Managers. The first part was published in the May HPAC, and the rest will appear later.

per cent latent heat, with the definite assurance that the resulting temperature conditions within the space will be comfortable for the majority of the occupants.

High Humidity Days

Probably one of the most difficult as well as important functions of an air conditioning system is its ability to supply proper comfort conditions during periods of only moderately high outside temperature but of high humidity. On a day of 80 deg outside, with high humidity and the sun obscured, there will be no heat gain from conduction or sun effect, but due to the people and lighting load, air conditioning will be required. The internal heat load may have decreased approximately 50 per cent, with the result that instead of the latent heat being 10 per cent of the total internal requirements, it becomes 20 per cent of the internal requirements. The air now admitted to this space, being conditioned for absorbing the conduction and sun loads, in addition to the lighting and people load, will not balance off at a comfortable temperature.

In order to preclude the cold, clammy atmosphere resulting from the conditions described, it is necessary to reheat the air *after* it has been chilled sufficiently in reducing the moisture content, so that when the final conditioned air is liberated into the room, it will absorb the internal sensible and latent heat in the proper proportion. This reheating may be accomplished by means of a bypass, steam coils, or by electric heating.

700 Ft Piping Tunnel For New Diesel Plant

UTILITY SERVICES required in the new diesel engine factory under construction at Caterpillar Tractor Co., Peoria, Ill., will be introduced into the factory through a service tunnel connecting with present utility lines situated more than 700 ft from the site of the new building.

All services—with the exception of gas, water lines for fire protection, and electricity—will be brought into the engine building through this tunnel of reinforced concrete construction of rectangular cross section 7 ft high and 7 ft wide with an overall length of 715 ft.

Extending from a terminal point adjacent to the present foundry service building, the tunnel will terminate in a basement utility room, from which all pipe lines will rise up into the building trusses for distribution throughout the building.

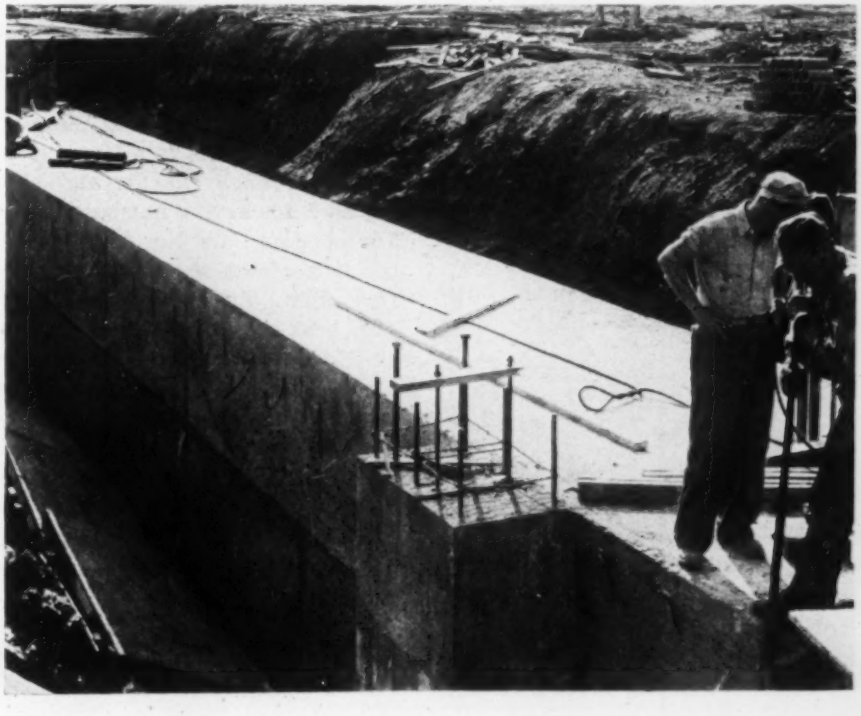
Pipe lines in the tunnel are supported on structural steel supports placed 10 ft on center with pipe roller and packless expansion joints to provide for pipe movement where required. Lines to be run through the tunnel include a 10 in., 150 lb steam line; a 6 in. condensate return line; an 8 in. compressed air line; a 6 in. domestic water line, and a 10 in. mill water line.

The basement utility room will house auxiliary equipment such as condensate receiver and condensate return pumps, storage type water heaters and circulating pumps, sump pumps, etc.

Provisions have been made, during construction, for keeping the tunnel dry by placing drain tile along both sides outside the tunnel, these tile draining into the sumps within the tunnel. The tunnel floor is sloped towards the sumps which are automatically drained by two duplex type sump pumps of 150 gpm capacity each. A third sump pump will be installed to drain the utility room of any water entering by seepage or otherwise.

The diesel engine building comprises one of the major items of the vast expansion program which will increase Caterpillar Tractor's manufacturing facilities by 50 per cent.

All services—with the exception of gas, water lines for fire protection, and electricity—will be brought into the new diesel engine factory in a 7 by 7 ft reinforced concrete tunnel 715 ft long



DATA SHEET

Simplified Procedure for SPECIFICATION WRITING

In the April 1946 Heating, Piping & Air Conditioning there was an article entitled A Simplified Procedure for Specification Writing, by George W. Campbell. Due to several requests, it was decided to run as a supplement to this article a series of specification cards which are currently being used by the firm of Urdahl and Everetts, consulting engineers, in their Washington, D. C., and San Francisco offices. Mr. Campbell is presently employed in the Washington office.

The cards have been duplicated by the "Ditto" process. After the original duplication on 8½ x 11 in. paper, the copies were cut into 5 x 8 in. cards. The "master" ("Ditto" terminology) was also cut out and filed in a 5 x 8 card file. The original cards have no dates. As the cards were revised, a date was added so that an obsolete card would not be used.

The cards are in two sections, a lettered series and a numbered series.

Let us assume a specific problem. We have designed a direct fired air conditioning system. We would go to the files and remove card No. A. Looking under paragraph 1, we note general intentions, scope of work, and time of bids. These items should be written on a 5 x 8 in. card or paper and should be given the numbers noted.

Consulting engineers and architects usually have a permanent set of conditions which they use for the particular locality in which they work covering such items as checking, definitions, delays and extensions, and accompanying drawings. These are included in paragraphs 2-31 indicated as printed matter; if we do not want to use 30 paragraphs for this material we can easily change the number.

Paragraph 32, work to be done by others, is another paragraph that will have to be written out for each job as every job will be different.

We now have arrived at the part of the system that is a time-saver. We go through the file and pick out all cards having numbers which are listed on Card No. A, following the title of the specification as direct fired air conditioning unit (1), heat exchanger (9), oil burner (11), etc. In our particular problem we won't need some of the cards. Let's assume we are not responsible for the domestic hot water system, which in this case is a plumbing job; therefore, we return card No. 39 (domestic water heater). Again, let us say the architect is to include in his specification all flashing where it is needed; therefore, we return card No. 34 (flashing).

We now take the cards and number them. Paragraph 33 of our specification will be given to direct fired air conditioning unit (Card No. 1), paragraph 34 to fuel oil tank (Card No. 23), etc. Should any of the cards now become separated, that loss will be easily detected when the secretary starts to type them.

After all the cards have been properly marked for the conditions of the particular job, we turn them over to the typist. After typing, the cards can be stapled together and placed in the job file.

The principal advantage of the system is that the engineer is saved time by not having to write out each specification every time it is desired to specify that item, and it eliminates errors which result from trying to transpose longhand. An added advantage is that an individual specification can be changed by substituting the newly written specification using the old number in place of the obsolete cards.

Some of the cards are reproduced this month and others will follow. Because of space limitations, they are shown smaller than the 5 x 8 in. size. These specifications are not necessarily to be construed as recommendations to other consultants but to illustrate this specification card file used by Urdahl and Everetts.

AIR CONDITIONING SYSTEM — Direct Fired — Card No. "A" Job No. ____

1.a. General Intentions
b. Scope of Work
c. Time of Bids

2-31 Incl. Printed Matter

32 Work to be done by others

___Direct Fired Air Conditioning Unit (1)
a. Heat Exchanger (9)
b. Oil Burner (11)
c. Fan (16)
d. Filters (8)
e. Humidifier (7)

___Domestic Water Heater (39)

___Fuel Oil Tank (23)

___Asbestos Connections (30)

___Sheet Metal Work (31)

___Dampers (32)

___Registers and Grilles (33)

___Flashing (34)

___Breeching (35)

___Piping
a. Cold water & drainage (38a)

___Pipe Hangers and Supports (40)

___Valves (45)

(over)

AIR CONDITIONING SYSTEM — Heating and Cooling with Coils — Card No. "C" Job No. ____

1. a. General Intentions
b. Scope of Work
c. Time of Bids
d. Limitations

2- Printed Matter
___ Work to be done by others

___Boiler (10)

___Stoker (12)
Oil Burner (11)

___Fuel Oil Tank (23)

___Breeching (35)

___Draft Control (73)

___Hot Water Heater, Domestic (25)

___Domestic Hot Water Tank (26)

___Compression Tank (24)

___Chilled Water Circulation Pump (20)

___Water Circulation Pump (18)
Condensate Return Pump (19)

___Sump Pump (21)

___Water Feeder and Low Water Cutoff (70)

___Compressor (13)

(over)

AIR CONDITIONING SYSTEM — Direct Expansion — Card No. "B" Job No. ____

1.a. General Intentions
b. Scope of Work
c. Time of Bids and Limitations

2-31 Incl. Printed Matter

32 Work to be done by others

___Compressors (13)

___Evaporative Condensers (15)
Water Cooled Condensers (14)

___Air Conditioning Units (2)
a. Fans (16)
b. Filters (8)
c. Coil Design, Cooling (6)

___Asbestos Connections (30)

___Sheet Metal Work (31)

___Dampers (32)

___Registers and Grilles (33)

___Flashing (34)

___Refrigerant Oil Separator (36)

___Flexible Connections (37)

___Piping
a. Cold Water & Drainage (38a)
b. Refrigerant Piping (38d)

___Hangers and Supports (40)

(over)

Card No. "C" cont. Job No. ____

___Valves
a. Plumbing (46a)
b. Hot Water & Steam (46b)
c. Refrigeration (46d)

___Magnetic Solenoid Valve (43)

___Pressure Reducing & Relief Valve (41)

___Thermal Expansion Valves (44)

___Flow Control Valves (42)

___Insulation (47)

___Thermometers & Pressure Gages (48)

___Electrical Work (49)

___Controls ( )

___Service, Water-Gas (50)

___Oiling the System (54)

___Painting (55)

___Cutting and Patching (56)

___Sleeves and Inserts (68)

___Vibration Eliminator Bases (57)

___Refrigerant Piping Tests & Charging the System (59)

___Pressure Tests, Steam (58)

___Adjustment and Trial Run (60)

___Shop Drawings (62)

___Instructions (63)

___Guarantee (64)

___Valves
a. Plumbing (46a)
b. Refrigerant (46d)

___Magnetic-Solenoid Valves (43)

___Expansion Valves (44)

___Refrigerant Strainers (65)

___Insulation (47)

___Thermometers & Pressure Gages (48)

___Electrical Work (49)

___Controls (53)

___Service, Water and Gas (50)

___Oiling the System (54)

___Painting (55)

___Cutting and Patching (56)

___Sleeves and Inserts (68)

___Vibration Eliminator Bases (57)

___Tests and Charging the System (59)

___Adjustment and Trial Run (60)

___Shop Drawings (62)

___Instructions (63)

___Guarantee (64)

___Insulation (47)

___Electrical Work (49)

___Controls (51)

___Oiling the System (54)

___Painting (55)

___Cutting and Patching (56)

___Sleeves and Inserts (68)

___Adjustment and Trial Run (60)

___Shop Drawings (62)

___Instructions (63)

___Guarantee (64)

___Evaporative Condenser (15)
Water Cooled Condenser (14)

___Cooling Tower ( )

___Air Conditioning Unit (2)
a. Fan (16)
b. Filter (8)
c. Coil Design, Heating (5)
d. Coil Design, Cooling (6)

___Water Chillers (4)

___Exhaust Fan (17)

___Asbestos Connections (30)

___Sheet Metal Work (31)

___Dampers (32)

___Registers and Grilles (33)

___Flashing (34)

___Refrigerant Oil Separator (36)

___Flexible Connections (37)

___Piping
a. Cold Water & Drainage (38a)
b. Steam Piping (38b)
c. Hot Water Piping (38c)
d. Refrigerant (38d)

___Hangers and Supports (40)

___Strainers, Steam (66)

___Traps, Steam (29)

RADIATION HEATING SYSTEM
Steam

Card No. "E"
Job No. ___

1. a. General Intentions
   b. Scope of Work
   c. Time of Bids
   d. Limitations

2- Printed Matter

___Work to be done by others

___Boiler (10)

___Stoker (12)
Oil Burner (11)

___Fuel Oil Tank (23)

___Breeching (35)

___Draft Control (73)

___Hot Water Heater, Domestic (25)

___Domestic Hot Water Tank (26)

___Condensate Return Pump (19)

___Sump Pump (21)

___Water Feeder & Low Water Cutoff (70)

___Radiation, Cast Iron (27)
Convectors (28)

___Unit Heaters (22)

___Piping
a. Cold Water & Drainage (38a)
b. Steam (38b)

(over)

RADIANT PANEL HEATING SYSTEM
Hot Water

Card No. "G"
Job No. ___

1. a. General Intentions
   b. Scope of Work
   c. Time of Bids
   d. Limitations

2. Printed Matter

___Work to be done by others

___Boiler (10)

___Stoker (12)
Oil Burner (11)

___Fuel Oil Tank (23)

___Breeching (35)

___Draft Control (73)

___Hot Water Heater, Domestic (25)

___Domestic Hot Water Tank (26)

___Water Circulating Pump (18)

___Compression-Expansion Tank (24)

___Radiant Heating Panels (76)

___Radiation, Cast Iron (27)
Convection Type (28)

___Unit Heaters (22)

(over)

RADIATION HEATING SYSTEM
Hot Water

Card No. "F"
Job No. ___

1. a. General Intentions
   b. Scope of Work
   c. Time of Bids
   d. Limitations

2- Printed Matter

___Work to be done by others

___Boiler (10)

___Stoker (12)
Oil Burner (11)

___Fuel Oil Tank (23)

(35)

___Breeching (35)

___Draft Control (73)

___Hot Water Heater, Domestic (25)

___Domestic Hot Water Tank (26)

___Water Circulating Pump (18)

___Compression-Expansion Tank (24)

___Radiation, Cast Iron (27)
Convection Type (28)

___Unit Heaters (22)

(over)

Card No. 1
Job No.___

DIRECT FIRED AIR CONDITIONING UNIT: Furnish and install an Air Conditioning Units in the basement and attic in the manner shown on the plans. The units shall consist of a fang, filter, steel heat exchanger with combustion chamber, oil burner, and humidifier, complete with all accessory local controls and assembled in a steel casing of approved design and with a neat appearance. The arrangement of the components shall be such that the dimensions of the units shall approximate those indicated on the plans, and it they shall meet the following requirements for capacity:

___Piping
a. Cold Water & Drainage (38a)
b. Hot Water (38c,

___Pipe Hangers and Supports (40)

___Flow Control Valve (42)

___Valves
a. Plumbing (46a)
b. Hot Water Heating (46b)
c. Radiator (46c)

___Pressure Reducing and Relief Valve (41)

___Air Vents (71)

___Square Head Cocks (45)

___Thermometers & Pressure Gages (48)

___Electrical Work (49)

___Controls (52)

___Insulation (47)

___Painting (55)

___Cutting and Patching (56)

___Sleeves and Inserts (68)

___Pressure Tests (58)

___Adjustment and Trial Run (Hot Water Heating System) (61)

___Instructions (63)

___Guarantee (64)

___Hangers and Supports (40)

___Strainers, Steam (66)

___Traps, Steam (29)

___Valves
a. Plumbing (46a)
b. Steam (46b)
c. Radiator (46c)

___Pressure Reducing & Relief Valve (41)

___Insulation (47)

___Thermometers & Pressure Gages (48)

___Electrical (49)

___Controls ( )

___Service, Water-Gas (50)

___Painting (55)

___Cutting and Patching (56)

___Sleeves and Inserts (68)

___Adjustment and Trial Run ( )

___Shop Drawings (62)

___Instructions (63)

___Guarantee (64)

___Piping
a. Cold Water & Drainage (38a)
b. Heating, Radiant Panel (38e)

___Hangers and Supports (40)

___Valve, Three-Way Mixing (75)

___Flow Control Valve (42)

___Valves
a. Plumbing (46a)
b. Hot Water Heating (46b)
c. Radiator (46c)

___Pressure Reducing and Relief Valve (41)

___Air Vents (71)

___Square Head Cocks (45)

___Thermometers & Pressure Gages (48)

___Electrical Work (49)

___Controls (77)

___Insulation (47)

___Painting (55)

___Cutting and Patching (56)

___Sleeves and Inserts (68)

___Pressure Tests (58)

___Adjustment and Trial Run (Hot Water Heating System, (61)

___Instructions (63)

___Guarantee (64)

Heating, Piping & Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

Effect of Floor Slab on Building Structure Temperatures and Heat Flow

By Carl F. Kayan,* New York, N. Y.

SUMMARY—Complex heat flow paths are to be found in building structures in a wide variety of forms and arrangement. Under such circumstances it is difficult, and generally impractical, to calculate steady-state heat flow and surface temperature distributions by orthodox mathematical or graphical techniques, particularly when surface conductances are involved on the high and low temperature sides.

This paper presents isotherms for different cases of building structure heat flow.

A description is given of apparatus and an experimental method for predetermining heat flow by means of electrical analogy.

COMPLEX heat flow paths are to be found in building structures in a wide variety of forms and arrangement. Under such circumstances it is difficult, and generally impractical, to calculate steady-state heat flow and surface temperature distributions by orthodox mathematical or graphical techniques, particularly when surface conductances are involved on the high and low temperature sides.

Especially difficult is the problem when the heat flow lines, by virtue of the complex heat path, are distorted. Herein the method of electrical analogy, applied to a geometrically similar model, offers the possibility of prediction of thermal values of heat flow and temperature distributions for the actual structure. It is to be noted at the very outset, however, that numerical values of surface conductance and wall conductivity must be assumed for the purposes of this procedure, similarly as in any other calculation technique; these assumptions are reflected in the final result.

One particular structural arrangement of interest is that representing an outside uniformly thick concrete wall with its attached floor slab, as shown in Fig. 1. For the case chosen, the outside surface is in contact with outdoor air at 0 F, while the inner surfaces are exposed to indoor air at 70 F. Under these circumstances, presuming steady-state conditions, heat will flow through the wall—at

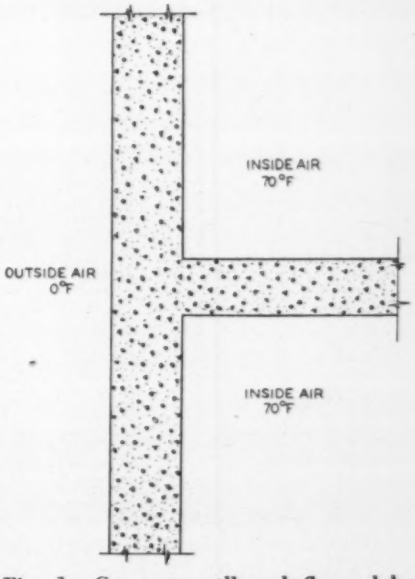


Fig. 1—Concrete wall and floor slab section

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some distance away from the horizontal floor slab—in undistorted fashion: the isotherms will be parallel to the wall surfaces. This is in accord with results of usual calculation technique. However, as the locale of the floor slab is approached, the conditions become more complicated, due to the heat flow from the slab in contact with the indoor air. Relative to the wall and in terms of heat transfer structure nomenclature, the slab in effect is an extended surface fin and thus represents a two-dimensional problem.

It is obvious that the surface temperatures of the vertical wall where one-dimensional heat flow takes place will be different from those of the slab some distance in, where no heat flow takes place by virtue of the slab being at the air temperature. In between these two extreme positions, the structure surface temperatures will vary, and such temperatures are difficult of prediction. With growing interest in radiant panel heating, involving calculation of mean radiant surface temperatures, knowledge of the structural surface temperature is highly desirable in order to permit estimation of values. Given conditions of quiescent air, with stratification such that the air above the floor is of lower temperature than that of the air below, the situation becomes still more complicated.

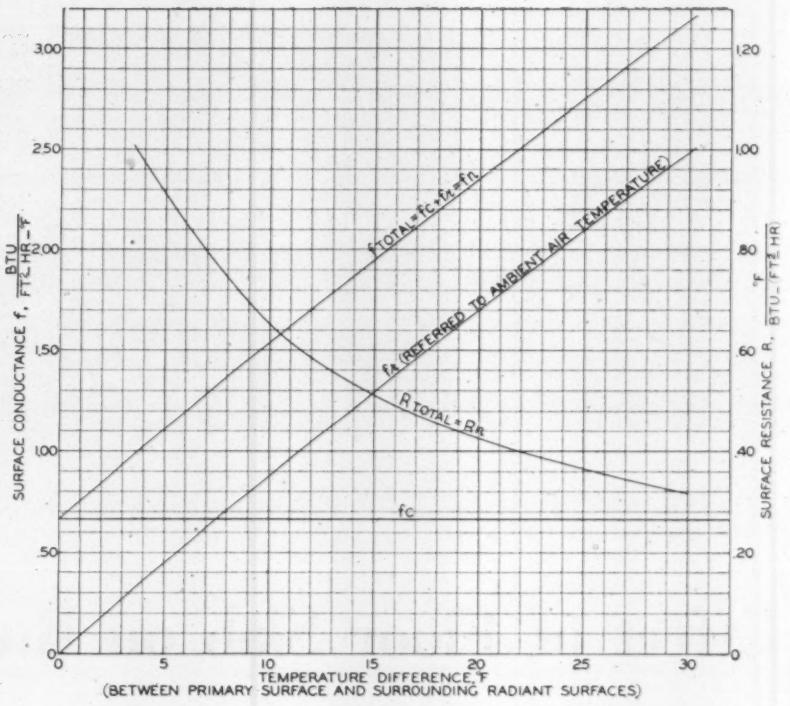
SURFACE CONDUCTANCE f, BTU/FT²-HR-°F
SURFACE RESISTANCE R, °F/BTU-FT²-HR
TEMPERATURE DIFFERENCE, °F
(BETWEEN PRIMARY SURFACE AND SURROUNDING RADIANT SURFACES)
f TOTAL = fc + fa = fn
fa (REFERRED TO AMBIENT AIR TEMPERATURE)
R TOTAL = Rn
fc

Fig. 3—Influence of radiation on surface film coefficient

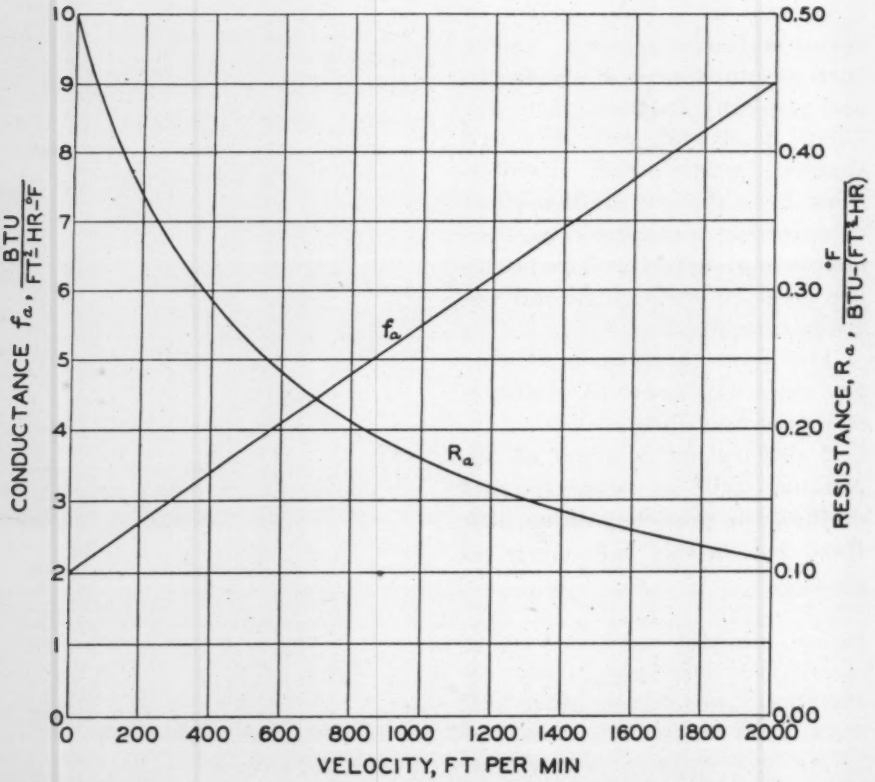

Fig. 2—Typical variation of air film conductance and resistance with wind velocity

It is to be noted that the heat transfer surface conductance varies primarily with the character of the surface temperature levels concerned, and with the velocity of the air motion. Such variation is a study in itself. For the purpose of the present analysis, it will be satisfactory, as far as is reasonable, to employ values conventionally used in building wall heat transfer calculations. Fig. 2 shows the typical variation of air conductance f_a—the so-called heat transfer air film coefficient, in Btu per (sq ft) (hr) (F deg), as a function of wind velocity, from Rowley et al, reported in the HEATING, VENTILATING, AIR CONDITIONING GUIDE, 1947 and elsewhere,[1] and is particularly intended for outside air conditions. The corresponding value of R_a—thermal resistance per square foot, F deg (sq ft) (hr) per Btu, has been added in Fig. 2.

Conventionally, the conductance f_i for the inside air is taken for still air and is customarily cited at a uniform value of 1.65 Btu per (sq ft) (hr) (F deg). Herein the values are open to question, particularly when the varying radiation effect of confronting surfaces and the relatively stagnant conditions of corner air are to be given

[1]Exponent numerals refer to References.

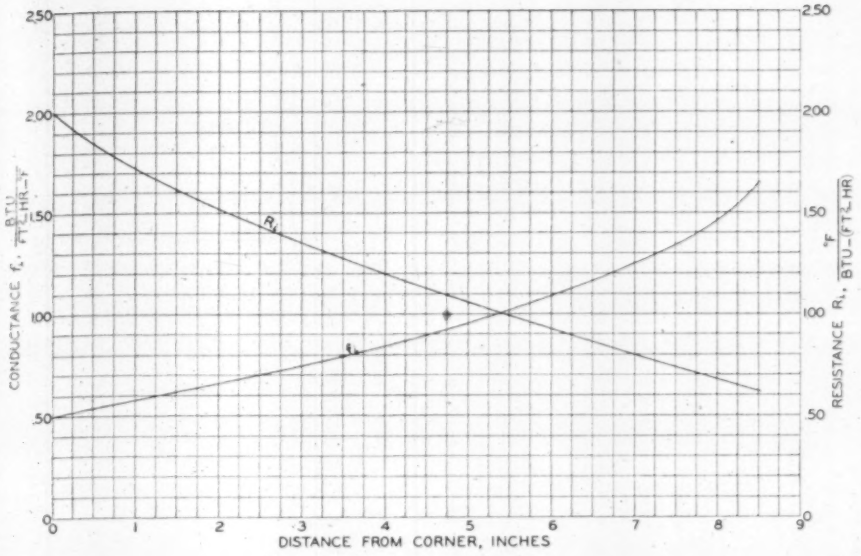

Fig. 4—Assumed variation of film conductance with distance from corner for construction shown in Fig. 1

consideration, and are certainly to be assumed as different from the customary value of 1.65.

The influence of radiation on the surface film coefficient under different conditions of temperature for confronting surfaces has been described in the HEATING, VENTILATING, AIR CONDITIONING GUIDE 1947.[2] Heat flow values are given for a vertical surface at 80 F, with ambient still air at 70 F, and effective emissivity at 0.83, the surrounding surfaces being at different temperatures. Fig. 3 shows a plot of the different results and shows the convection conductances f_c, the equivalent radiation conductance f_r, net total equivalent surface conductance f_n, and the corresponding thermal resistance per square foot R_n. With differing wall temperatures prevailing in a room, the importance of the actual value of f_n is apparent. It should, of course, be noted that the radiation conductance f_r could have a negative value.

In view of the foregoing circumstances of stagnant corner air, it is reasonable to assume that the effective surface conductance will be considerably reduced as the corner is approached. Fig. 4 shows an assumed variation of f_i as a function of distance from the corner, along with its corresponding value of unit thermal resistance R_i (further experimental work to establish this variation is desirable and is separately under study).

Experimental Program

The purpose of this paper is to investigate temperature distribution and heat flow for a single case of a concrete wall with its attached floor slab shown in Fig. 1. Different conditions are presumed to exist for the outside conductance f_o, for which the typical variation is given in Fig. 2. The inside conductance f_i is assumed to vary in accordance with the values as given in Fig. 4, rising to a constant value of 1.65 for quiescent air at a distance of 8 in. from the inner corners, the same values being taken for both the horizontal and the vertical surfaces. The conductivity of concrete is assumed as $k = 9.00$ Btu per (sq ft) (hr) (F deg per in.); the wall is 8 in. thick, and the attached floor slab 6 in. Inside air is taken at 70 F, outside air at 0 F, with three separate values of f_o of 2.00, 3.00, and 6.00. An additional case is analyzed in which the floor air is presumed to be lower in temperature than the ceiling air by 10 per cent, with the average of the two at 70 F, thus accounting for some air stratification. This case has been studied with f_o at 6.00.

Isotherms are plotted to illustrate the distortion of temperature lines by the presence of the attached fin-like slab, as compared with those resulting in the wall some distance away from the slab, where they are regularly spaced and parallel to the wall surfaces. Fig. 5 shows the temperature distribution fraction as a function of thermal resistance R for two cases of $f_o = 2.00$ and 6.00, from which the corresponding wall surface temperatures for one dimensional flow may be inferred; the resistance values are in proper relationship to one another although their values are arbitrary.

The investigation has been carried on through the use of the resistance-concept Analogger previously described by the author.[3]

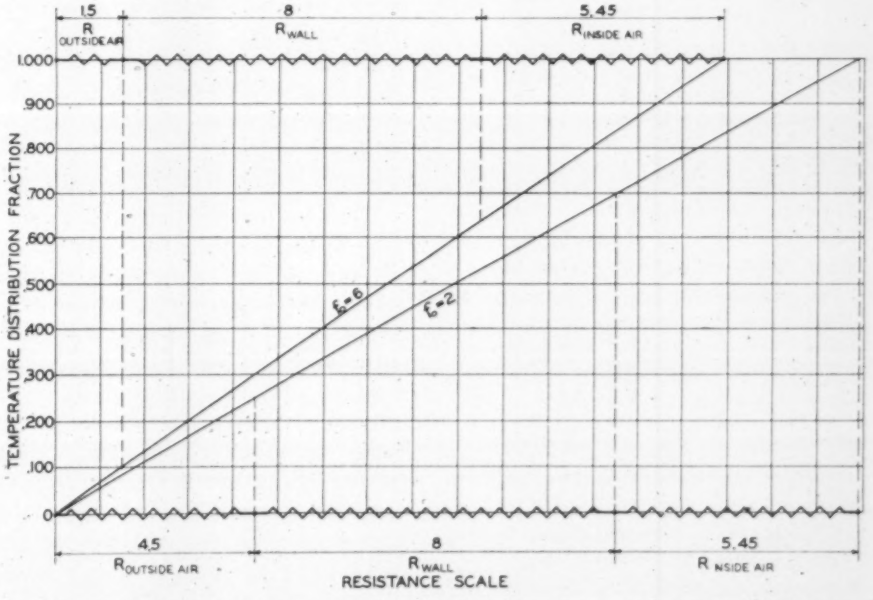

Fig. 5—Variation of temperature distribution fraction with thermal resistance for $f_o = 2$ and $f_o = 6$

Briefly, this embodies a geometrical type of analogue for steady-state conditions based on the resistance concept which recognizes the general similarity between heat flow and electrical flow. It is to be noted that the use of electrical analogies for simple cases is not new, particularly as involving isothermal surfaces, and there are references in the literature (more particularly in the European) starting with the work of Langmuir[4] here in 1913. The heat flow model of the Analogger† has the same geometrical configuration as the original structure cross-section, and uses electrically conductive flat sheet along which electrical flow takes place.

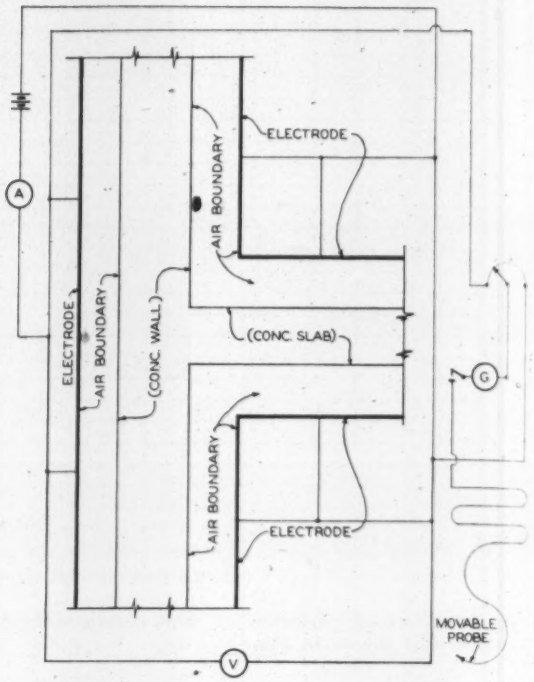

Fig. 6—Electrical circuit of Analogger in test of concrete wall and slab section

Application of the Electrical Analogger

The geometrical electrical analogy facilitates the experimental procedures and permits not only ready prediction of temperatures throughout a heat flow path, but also quantitative prediction of heat flow in accordance with assumed conditions. Basically it recognizes the application of the so-called Ohm's law for electrical circuits to equivalent thermal circuits.

The relationships are easily stated:

$$i = \frac{\Delta e}{r};\quad e = ir \qquad \ldots\ldots\ldots (1)$$

where

i = electrical current, amperes
Δe = potential difference, volts
r = electrical resistance of the flow circuit, ohms

Similarly, the rate of heat flow depends on temperature difference and the equivalent resistance to heat flow; this principle is identified as the resistance concept of heat transfer. Thus:

$$H = \frac{\Delta t}{R};\quad \Delta t = HR \qquad \ldots\ldots\ldots (2)$$

where

H = heat flow rate per unit of area, Btu (sq ft) (hr)
Δt = overall temperature difference, F
R = thermal resistance per unit of area, deg F (sq ft) (hr) per Btu

In addition, to cover the case of overall conditions for area A:

$$q = HA = \frac{\Delta tA}{R} \qquad \ldots\ldots\ldots (3)$$

where

q = gross heat flow, Btu per hr
A = heat flow reference area, sq ft

For a heat flow path between two temperature levels, equivalent temperature conditions throughout may be determined from the simulating electrical flow path, if the component electrical resistances have the same relationship between themselves as have the thermal resistances. Accordingly, for the electrical model representing a wall transferring heat, electrical potentials throughout will be representative of the temperature conditions.

Thus the problem consists in setting up an electrical model in which all the thermal resistances of the heat transfer arrangement are represented by appropriate electrical resistances. This is accomplished in the Analogger through the use of electrically conductive flat sheet with intimately contacting electrodes mounted thereon to represent the conditions of the fluid boundaries of the thermal structure. In using uniform sheet, linear distances on the sheet are commensurate with resistances. The pattern of the heat transfer wall is thus laid out in geometrical equivalence thereon. Offsetting the electrode on the sheet by a given distance from the wall profile is equivalent to introducing an additional resistance to heat transfer between the boundary fluid at its prevailing temperature and the wall itself.

The general fluid boundary resistance R may be defined through the fluid conductance f:

$$R = \frac{1}{f} \qquad \ldots\ldots\ldots (4)$$

where

R = equivalent boundary resistance per sq ft, deg F (sq ft) (hr) per Btu
f = surface conductance (*film coefficient*), Btu per (sq ft) (hr) (F deg)

The thermal resistance R_w of wall material of uniform composition is

$$R_w = \frac{x_w}{k_w} \qquad \ldots\ldots\ldots (5)$$

where

x_w = thickness of wall material, inches
k_w = thermal conductivity of wall material, Btu per (sq ft) (hr) (F deg per in.)

For a given value of f, such as f_a for an air boundary, having its corresponding value of R_a, there is some equivalent thickness x_e of wall material which will give the same resistance R_e to heat transfer as the fluid boundary:

†Name coined to represent the equipment for logging the isopotentials and resistances.

$$R_a = \frac{1}{f_a} = R_e = \frac{x_e}{k_w} \quad \text{.....(6)}$$

From this it follows that

$$x_e = \frac{k_w}{f_a} \quad \text{.....(7)}$$

Thus the equivalent electrical resistance to permit simulation of thermal conditions on the Analogger would be proportional to x_e and x_w to represent the fluid and the wall, if just a simple wall and fluid were in question. When using flat electrically conductive and uniform sheet for one- and two-dimensional Analogger studies, these resistances could be represented by proportional distances or lengths l_e and l_w, thus permitting a model of the heat flow path thermally in scale.

Experimental Procedure

In the present problem, an 8 in. wall section has been analyzed for a 60 in. height, the 6 in. slab of 23 in. length being joined to it at the mid section and of uniform homogeneous material of the same conductivity, $k_w = 9.00$, as the wall itself. The Analogger model for convenience was made full scale, with distances on the sheet equal to the structure dimensions. Its electrical circuit is shown in Fig. 6. Computation of the resultant electrical resistance of the model between the electrodes for the different arrangements is possible through the determination of the overall voltage and the circuit current as supplied by the electrical source. By means of a parallel slide wire arrangement, deflecting galvanometer, and movable probe, potential distribution over the electrical sheet was determined. In this connection, use was made of a potential difference fraction defined as follows:

$$c = \frac{\Delta e_p}{\Delta e} \quad \text{.....(8)}$$

where

Δe_p = electrical potential difference from zero base to a given point p

Δe = overall electrical potential difference between electrodes

Thus c, the fraction of the overall potential difference at any point,

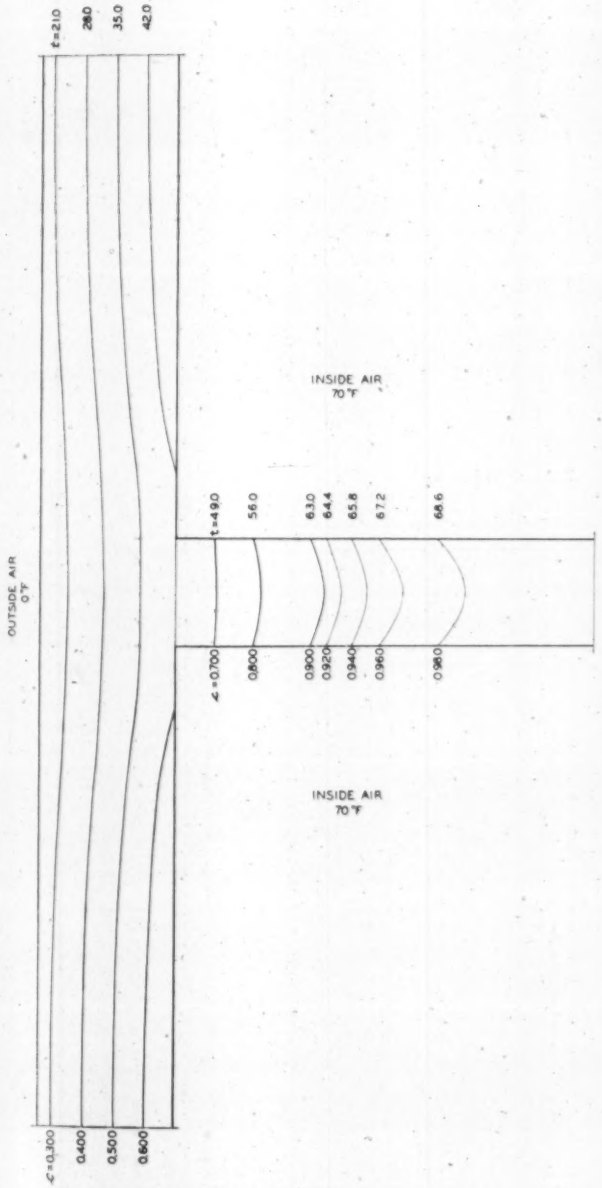

Fig. 7—Isopotential pattern for Series I ($f_a = 2$)

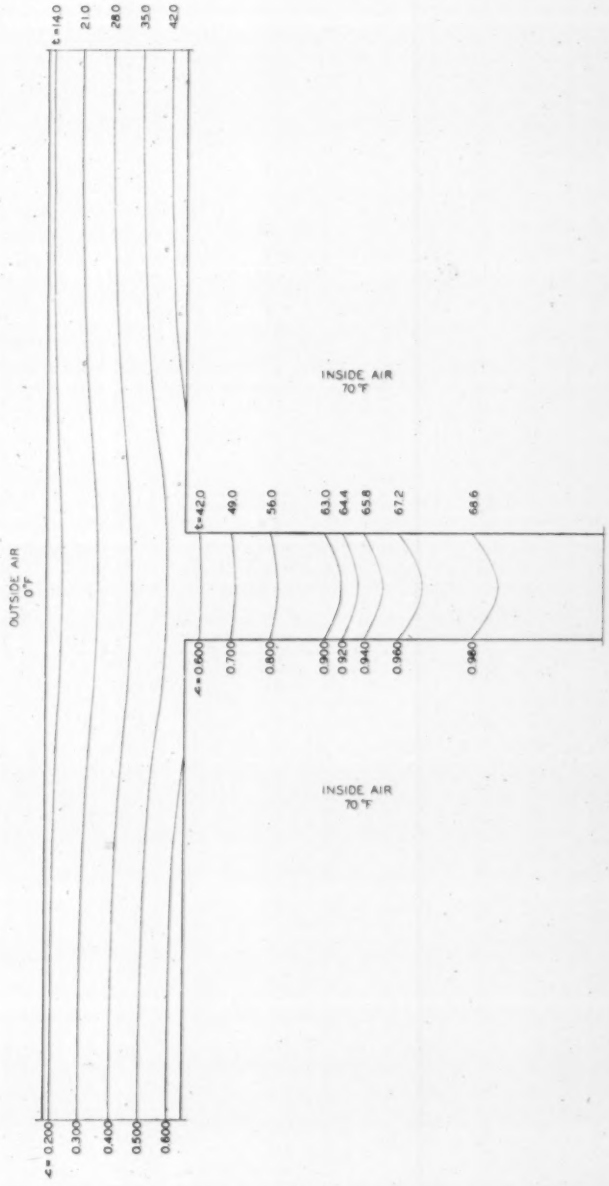

Fig. 8—Isopotential pattern for Series II ($f_a = 3$)

JOURNAL SECTION

could be determined and the isopotential lines developed thereby. Equivalent temperatures followed from values of c and the overall temperature difference:

$$t_p = t_o + c\Delta t_{o-i} \quad \ldots\ldots\ldots\ldots (9)$$

where

t_p = temperature at a given point p, Fahrenheit
t_o = temperature of outside air, Fahrenheit
Δt_{o-i} = temperature difference between inside and outside air, F deg

Thus, for 70 F temperature difference with outside air at 0 F, for $c = 0.400$ at a given point, p, $t_p = 0 + 0.400 \times 70 = 28.0$ F.

As previously noted, the distance of offset for the outside-air electrode from the wall profile depends on the conductance f_o. For values of $f_o = 2.00$, 3.00, and 6.00 to be studied, with the Analogger model made to scale, the corresponding values of l_b in accordance with Equation 7 were 4.5, 3.0, and 1.5 in., it being recalled that $k_w = 9.00$. For the inside air, f_i was taken as 1.65 for those sections more than 8 in. away from the corner, thus for the model, $l_e = 5.45$ in. on both wall and slab surfaces. For the inner 8 in. to the corner, the equivalent resistance in accordance with the assumed curve of Fig. 4 was obtained by appropriate cutting of the boundary sheet material to produce resistance effects in accordance with the curve. Throughout, the sheet material representing the air boundaries was slit to prevent lateral electrical flow, thus to more adequately simulate surface conductance effects.

Results of Investigation

The resultant isopotential patterns are shown in Figs. 7, 8, and 9 for Series I ($f_o = 2$), Series II ($f_o = 3$) and Series III ($f_o = 6$) respectively. Here the distortions due to the slab heat flow for the isopotential lines and the corresponding isothermal lines may readily be observed. The variation of the temperature across the vertical sections of the slab is distinctly evident. From this it may be parenthetically noted that the conventional assumption of uniform temperature at any section so often

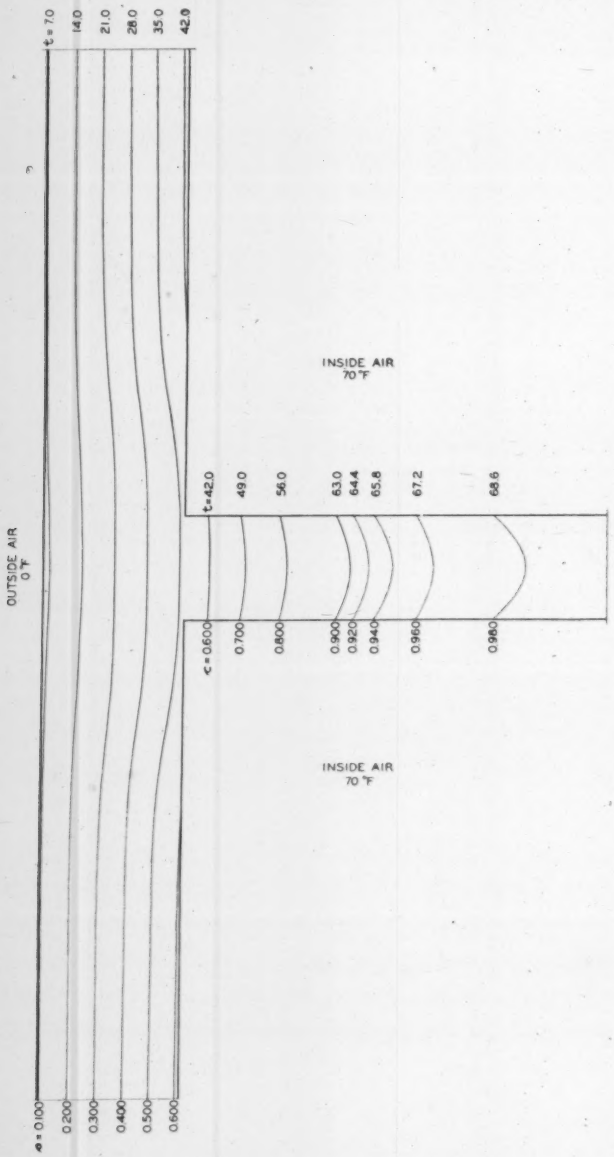

Fig. 9—Isopotential pattern for Series III ($f_o = 6$)

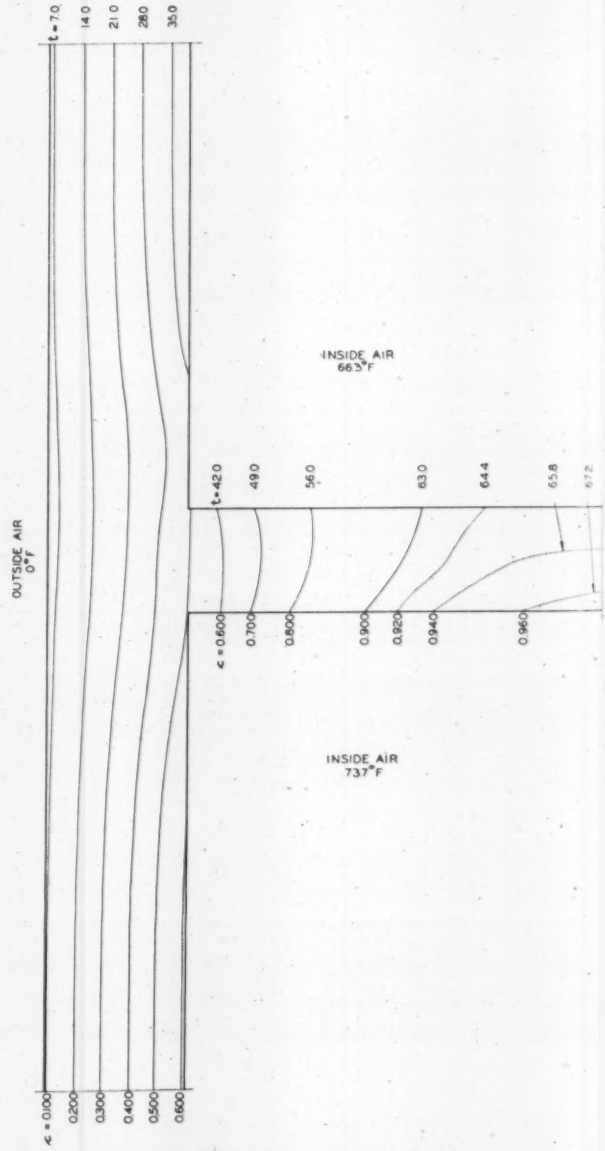

Fig. 10—Isopotential pattern for Series IV ($f_o = 6$) with air temperature difference above and below slab

made for the mathematical solution of fin problems is here not sustained. (The usual mathematical assumption of uniform surface conductance along the *fin* was not allowed here.)

The effect of different outside conductances f_o and their equivalent resistances is to be noted in comparison of these three figures. At the ends of the wall sections remote from the slab, the isotherms become straight, and position in accordance with conventional one-dimensional heat flow, such as indicated in Fig. 5. The patterns for Figs. 7, 8, and 9 are symmetrical about the horizontal axis through the slab.

Of considerable interest are the results of Series IV, given in Fig. 10. As previously noted, the floor air temperature is taken as lower than that of the ceiling, to account for room air stratification. Specifically, the air in the ceiling section is uniformly taken at 73.7 F, and that in the floor section at 66.3 F (90 per cent of 73.7); the average is 70 F. The values of c are referred to 73.7 as the basic value. Again here the isotherms flatten out to their normal positions at each end of the wall. The floor slab to some extent transmits heat from the underside to the top. The patterns here are non-symmetrical, and the distortions are hardly predictable with facility by any other conventional type of analysis.

The surface temperature results for the different series are given in Fig. 11 and emphasize the effect of the slab heat flow on the surface temperature distributions. Despite the adjustment in the value of f_i to account for corner stagnation, as given in Fig. 4, the slab surface temperatures present a general pattern customarily expected for fins.

From the results of the overall resistances in the different cases, predictions of ultimate heat flow through the combined slab-wall thermal path are possible. Following the methods previously described by the author in another paper,[5] the resistance results are correlated by plotting the ratio of electrical resistances against an operating characteristic m. Specifically, ratio r_t/r_w is plotted against $m = r_o/r_w$. Here, for Fig. 12:

r_t = measured electrical resistance between the electrodes for the full scale model under different conditions

r_w = electrical resistance of the model strip representing the plain wall section 8 in. thick

r_o = electrical resistance of the model strip l_o representing the outside air, variable with f_o

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Another line is shown representing the variation of r_{o-1}/r_w with m, where r_{o-1} = electrical resistance of a uniform model strip for one-dimensional flow, comprising the series resistances equivalent to the outside air, wall and inside air for the full length of the 60 in. wall without a slab. A further line shows the ratio of r_t/r_{o-1} vs. m, and in effect this may be directly translated into the equivalent thermal resistance ratio R_t/R_{o-1}

R_{o-1} = series total for $R_o + R_w + R_i$

for the actual slab-wall combination as compared with the same length plain wall having $f_i = 1.65$, and f_o as selected.

where

R_t = equivalent thermal resistance of wall slab assembly referred to average unit area for the combination

It will be apparent then that the thermal counterparts of the previous electrical values will be related to m as given by the equation:

$$m = M = R_o/R_w \quad \ldots\ldots\ldots\ldots (10)$$

where

M = operating characteristic for thermal transfer correspond-

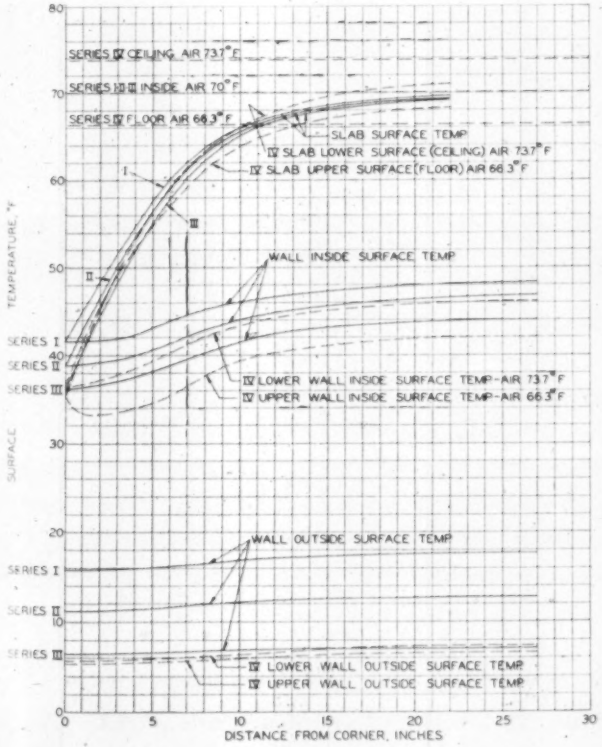
SERIES IV CEILING AIR 73.7°F
SERIES II & III INSIDE AIR 70°F
SERIES IV FLOOR AIR 66.3°F
SLAB SURFACE TEMP
IV SLAB LOWER SURFACE (CEILING) AIR 73.7°F
IV SLAB UPPER SURFACE (FLOOR) AIR 66.3°F
WALL INSIDE SURFACE TEMP
IV LOWER WALL INSIDE SURFACE TEMP-AIR 73.7°F
IV UPPER WALL INSIDE SURFACE TEMP-AIR 66.3°F
WALL OUTSIDE SURFACE TEMP
IV LOWER WALL OUTSIDE SURFACE TEMP
IV UPPER WALL OUTSIDE SURFACE TEMP
SERIES I
SERIES II
SERIES III
TEMPERATURE, °F
SURFACE
DISTANCE FROM CORNER, INCHES

Fig. 11 *(left)*—Variation of surface temperature with distance from corner (for construction shown in Fig. 1)

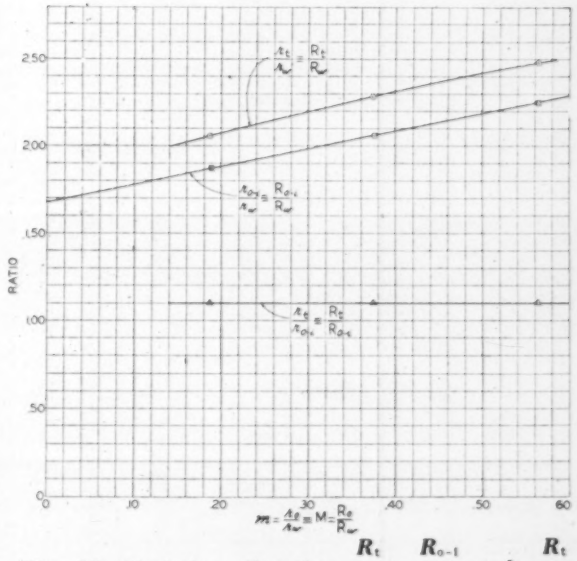

Fig. 12—Variation of ratios $\frac{R_t}{R_w}$, $\frac{R_{o-1}}{R_w}$ and $\frac{R_t}{R_{o-1}}$ with change in ratio $\frac{R_o}{R_w}$

ing to m for the electrical system

$$R_o = 1/f_o$$

$$R_w = \frac{x_w}{k_w}$$

In effect then, the transition is made between the electrical results and the equivalent thermal resistance ratios for the wall arrangements in question. Thus heat flow values, in terms of unit areas of wall surface, may be compared with those resulting for a simple wall in one-dimensional heat transfer. Furthermore, since dimensionless values are employed, Fig. 12 offers the possibility of applying these results to other combinations of physical properties for the same general shape configuration.

Complex Case with Multiple Wall Materials

It is of interest to briefly mention another case studied in the Analogger Laboratory, involving heat flow analysis for a wall arrangement comprised of structural and insulating materials, and previously described by the author.[3] This concerns a cold storage application, and though of different temperature range from the preceding case, bears a relationship to it. Fig. 13 shows the structural arrangement, with *freezer* and *cooler* cold storage spaces presenting the different temperature levels. In detail this differs from the present case in that the complex heat flow path involves wall material of differing conductivity.

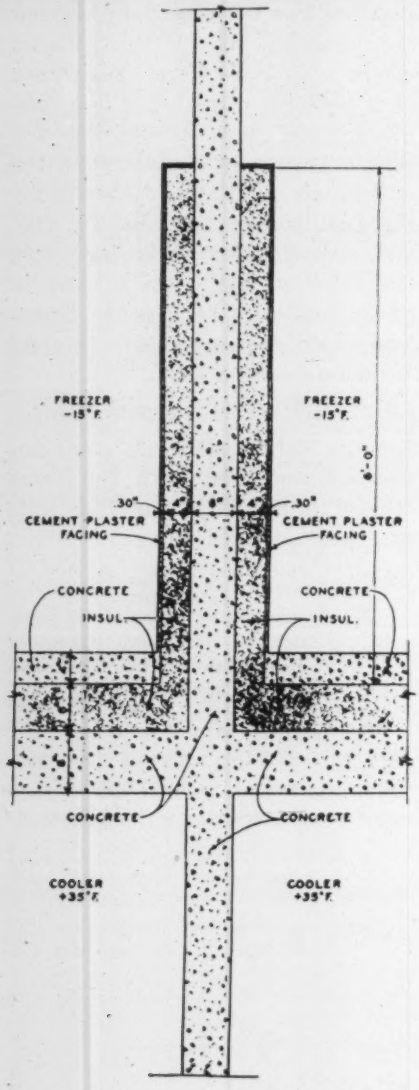

Fig. 13—Complex cold storage wall

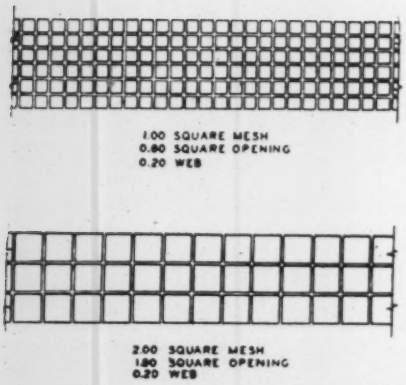

Fig. 14—Perforation of electrical conducting sheet to simulate increased resistance of insulation

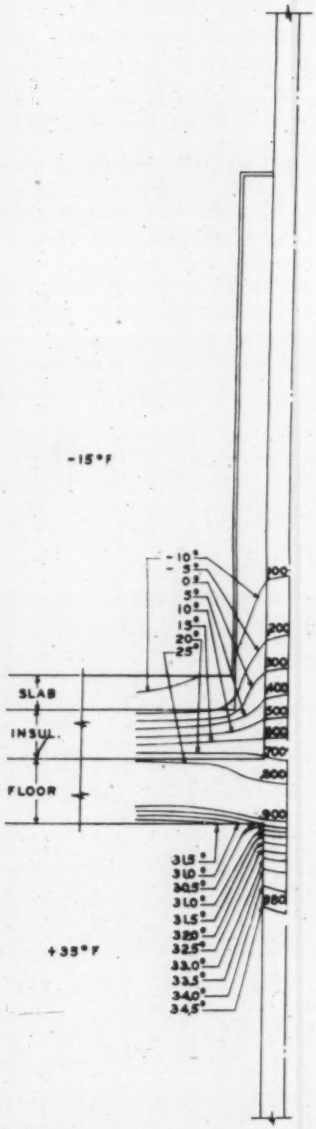

Fig. 15—Isotherms for insulation to wall material resistance ratio of 4.6

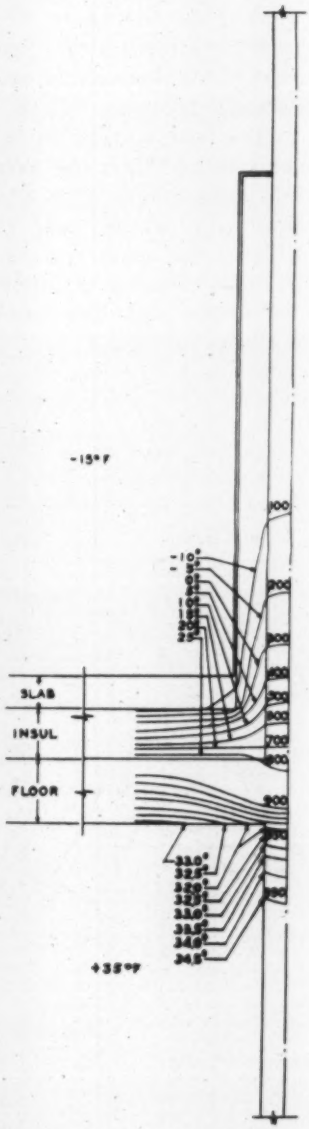

Fig. 16—Isotherms for insulation to wall material resistance ratio of 9.2

Since the structural arrangement was symmetrical about the vertical axis, only one side required study. The insulation, of lower conductivity than the concrete wall, required that in the flat sheet model the characteristics of the sheet section for the insulation be different from that for the wall. The problem that this offered was ultimately solved by perforating the sheet for insulation simulation in a square mesh pattern, such as shown in Fig. 14. Here the sheet resistance was distinctly increased for the meshed section vs. the unmeshed, and could be altered further by going to progressively larger meshes, as indicated in the figure.

The particular objective in this case was to determine the surface temperatures on the underside so that the possibility of condensation and frost accumulation on the surfaces could be studied. Figs. 15 and 16 depict the isotherms and the surface temperatures for the cases of one-inch and two-inch mesh, equivalent to resistance ratios vs. wall material of 4.6 and 9.2, respectively.

In conclusion, it must again be emphasized that the results obtained depend directly on the assumptions for the physical factors of wall conductivity, and inside and outside boundary conductances.

Acknowledgment

Acknowledgment is hereby made to different associates of the author who have cooperated on various aspects of the investigation: to Barbara Sherman Kayan for development of the isopotential patterns, and to R. G. Vanderweil, Chase Brass and Copper Co., Waterbury, Conn., who among others suggested the study of the problem.

This paper reports the results of investigations supported in part by a grant-in-aid to Columbia University from The Refrigeration Research Foundation, Inc.

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TECHNICAL SOCIETIES COUNCIL OF NEW YORK, INC.

The Technical Societies Council of New York has received its certificate of incorporation under the laws of the State of New York dated April 7, 1947.

A War Production Committee was organized during the early days of the war at the request of Donald M. Nelson and subsequently coming under the direction of J. A. Krug, which was disbanded following the war after serving many useful purposes. This was the nucleus which formed the Technical Societies Council of New York.

The Council organized on July 16, 1946, is composed of engineering and technical societies in Greater New York and has as its main objectives the advancement of engineering, scientific or technical knowledge and the practice of high professional standards.

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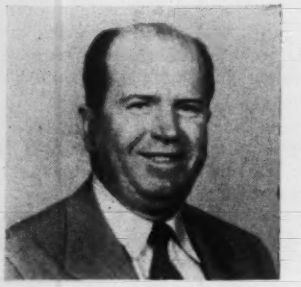

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Comfort Reactions of 275 Workers During Occupancy of Air Conditioned Offices

By Frank B. Rowley*, Richard C. Jordan**, and Warren E. Snyder†
Minneapolis, Minn.

This paper is the result of research sponsored by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS in cooperation with the Engineering Experiment Station, University of Minnesota

SUMMARY—This paper reports the results of a study of the general reactions of 275 employees during working hours. It is pointed out by the authors that the conclusions refer to only a particular office and a group of employees and may not be applicable to other groups.

The maximum number of persons indicating comfort occurred at a dry bulb temperature of 74 F and variations of relative humidity between 35 and 60 per cent caused no change in the feeling of comfort.

The lack of humidity effect on feeling of warmth is ascribed partly to inherent limitations of the effective temperature index and partly to the many factors which enter into an individual's feeling of warmth. These factors could be controlled in laboratory tests but not in the test in a business office.

THE EFFECTIVE temperature scale[1] which relates the dry bulb temperature and relative humidity to the feeling of warmth was derived largely through ASHVE Laboratory investigations. Inasmuch as the scale is to be applied to air conditioning installations where a number of additional comfort affecting factors, such as solar radiation, health of the individuals, attitude toward the test, etc., are present, a check of its validity during practical application was desired.

Suitable data for this study were available from a cooperative survey previously made in the air conditioned offices of the Minneapolis-Honeywell Regulator Co. These offices were occupied by 275 employees, including both men and women who had an age distribution of from slightly below 20 years to 70 years and who were, in general, representative of persons found in a typical office. The data were used originally to determine the optimum effective temperature for summer cooling requirements in Minneapolis and were reported in the ASHVE TRANSACTIONS.[2,3,4]

Method of Obtaining Data

The original data were obtained from questions answered by the employees. One question, namely, general reactions during working hours, was independent of entering or leaving shock effects and was the only question used in the survey. Since this information was obtained at approximately 10:30 a.m. and 3:00 p.m., the subjects had arrived at a steady physiological state and were adapted to the room temperature. In the development of the original effective temperature scale, the subjects recorded their reactions when passing from one atmospheric condition to another. Therefore, it is not to be expected that the steady state reactions will necessarily be the same as those obtained by the comparison method and the question arises as to which should be used as the basis for effective temperature.

The ASHVE Research Laboratory has used over a period of years a comfort reaction scale in which

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**Professor and Assistant Head, Department of Mechanical Engineering, University of Minnesota. Member of ASHVE.

†Instructor, Department of Mechanical Engineering, University of Minnesota.

[1]HEATING, VENTILATING, AIR CONDITIONING GUIDE, 1947, p. 217.

Presented at the Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Coronado, Calif., June 1947.

[2]Summer Cooling Requirements of 275 Workers in an Air Conditioned Office, by A. B. Newton, F. C. Houghten, Carl Gutberlet and R. W. Qualley. (ASHVE TRANSACTIONS, Vol. 44, 1938, p. 337.)

[3]Shock Experiences of 275 Workers After Entering and Leaving Cooled and Air Conditioned Offices, by A. B. Newton, F. C. Houghten, Carl Gutberlet, R. W. Qualley and M. C. W. Tomlinson. (ASHVE TRANSACTIONS, Vol. 44, 1938, p. 569.)

[4]General Reactions of 274 Office Workers to Summer Cooling and Air Conditioning, by F. C. Houghten, A. B. Newton, R. W. Qualley and Edward Witkowski. (ASHVE TRANSACTIONS, Vol. 44, 1938, p. 591.

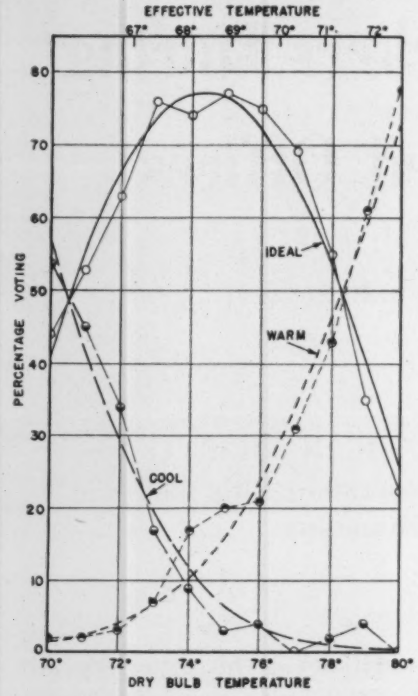

Fig. 1—40 per cent relative humidity

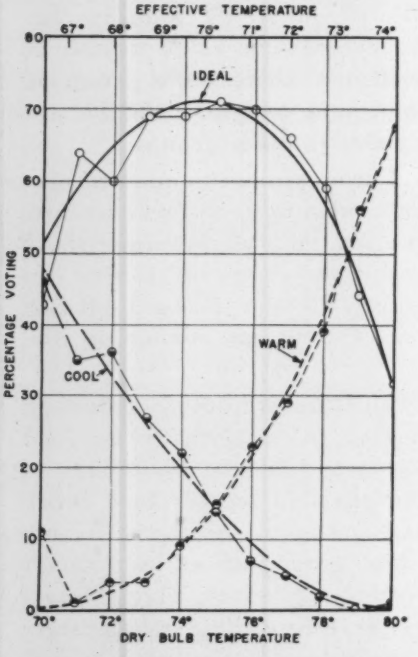

Fig. 2—55 per cent relative humidity

(*1*) represented severely cool; (*2*) cool; (*3*) comfortably cool; (*4*) ideal comfort; (*5*) comfortably warm; (*6*) warm; and (*7*) severely warm. In recording the original data the classifications of comfortably cool (*3*) and comfortably warm (*5*) were found to be confusing and, thus, were eliminated. The reactions checked were severely cool (*1*), mildly cool (*2*), ideal (*4*), mildly warm (*6*), and severely warm (*7*). In making the present study it was found that the percentages of persons voting severely cool (*1*) and severely warm (*7*) were quite small and erratic. The tabulation was further simplified by combining all cool votes and all warm votes, leaving only the three classifications of cool (*2*), ideally comfortable (*4*), and warm (*6*).

Tabulation of Data

In the present study all pertinent information for each questionnaire, including the date, name, sex, age, location in building, inside temperature and humidity, outside temperature and humidity, and answers to all questions, was coded and punched on an IBM card. These cards were first sorted by inside dry bulb temperatures in intervals of 1 deg and by inside relative humidity in intervals of 5 per cent. For the purpose of this grouping, humidities from 33 to 37 per cent inclusive were combined and called 35 per cent, humidities from 38 to 42 per cent inclusive were combined and called 40 per cent, etc. The total number of votes recorded for cool, ideally comfortable and warm were tabulated for each condition and the percentage of cool, ideally comfortable and warm votes were calculated. It was found that the number of votes contained in the extremes of the data was too small to be significant and these votes were discarded, leaving the temperature range from 70 F to 80 F and the humidity range from 35 to 60 per cent.

Six graphs were constructed, one for each 5 per cent group of relative humidities from 35 to 60 per cent. Two typical graphs are shown in Figs. 1 and 2. The dry bulb temperature was used as the abscissa and the percentage of persons voting for each of the three conditions (cool, ideally comfortable, and warm) as the ordinate. After the points were plotted, smooth curves were drawn through them and the remainder of the study was based on data from these smoothed curves rather than from the original data. This was done in order to minimize the dispersion of points and to obtain percentages

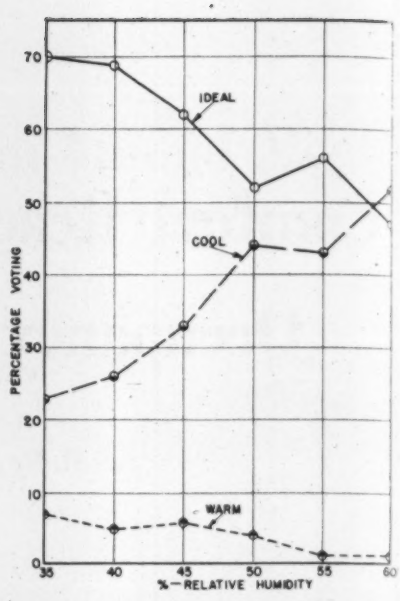

Fig. 3—67 deg effective temperature

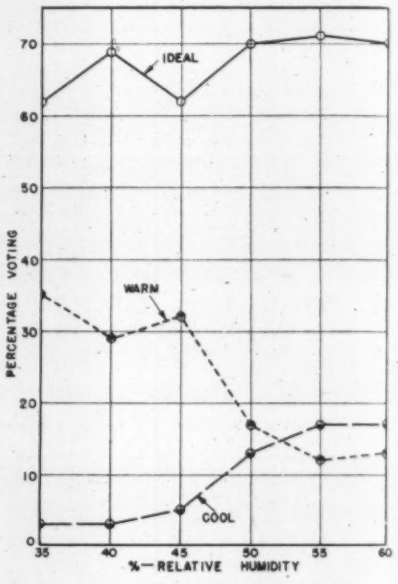

Fig. 4—70 deg effective temperature

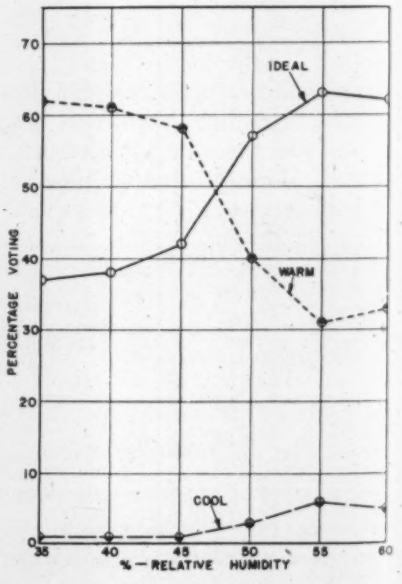

Fig. 5—72 deg effective temperature

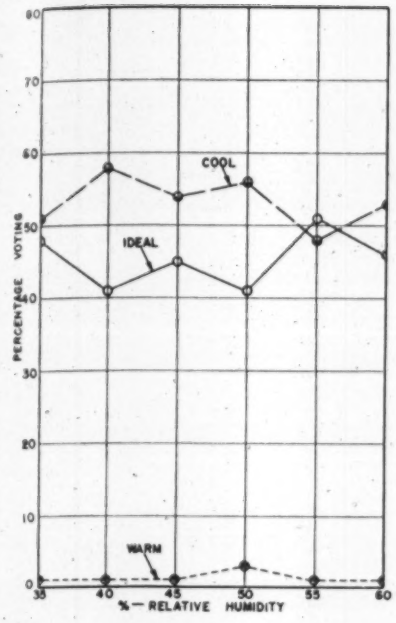

Fig. 6—70 deg dry bulb temperature

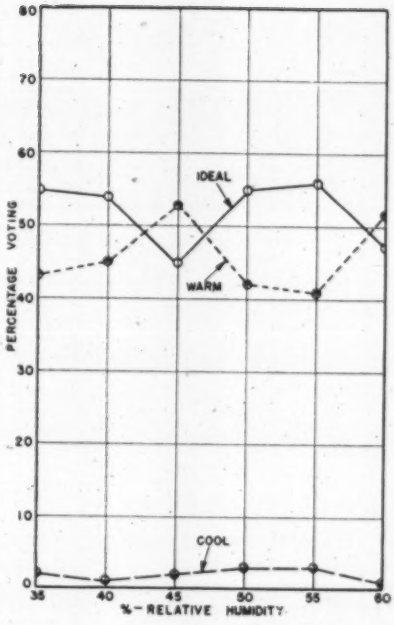

Fig. 8—78 deg dry bulb temperature

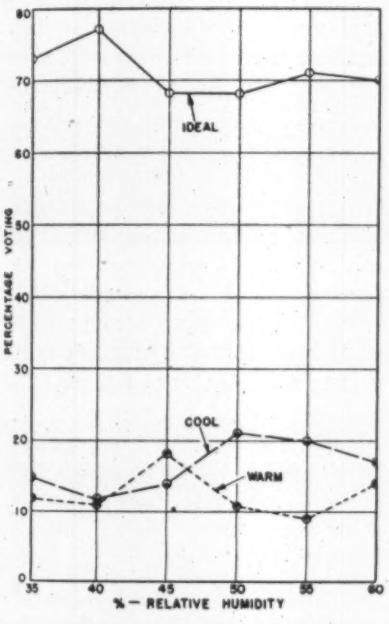

Fig. 7—74 deg dry bulb temperature

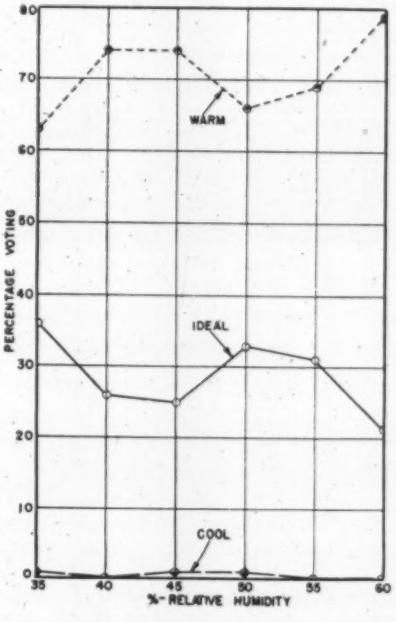

Fig. 9—80 deg dry bulb temperature

corresponding to effective temperatures.

Using the values as obtained from the six graphs, new graphs were plotted for each effective temperature from 67 to 72 deg, with the percentages of persons voting for each of the three conditions as the ordinates and with the relative humidity as the abscissa. Three typical curves are shown in Figs. 3, 4 and 5 for 67, 70 and 72 deg ET respectively.

Again using values as obtained from the original six graphs, additional graphs were made for dry bulb temperatures from 70 F to 80 F, with the percentages of employees voting for each of the three conditions as the ordinates and the relative humidity as the abscissa. Four typical curves are shown in Figs. 6 through 9 for temperatures of 70, 74, 78 and 80 F.

A study of Figs. 3, 4 and 5 showing the variation in the percentages of employees feeling cool, ideally comfortable and warm for a given effective temperature reveals that in every graph the percentage of occupants feeling warm decreases and the percentage feeling cool increases as the humidity increases with corresponding decreases in the dry bulb temperature, even though the effective temperature remains fixed. These changes in the percentages would not be expected at a constant effective temperature; for, by definition, an effective temperature is one which indicates conditions of equal warmth. The fact that these curves do show that the employees studied became cooler as the humidity increased and dry bulb temperature decreased, despite a constant effective temperature, would indicate that with this particular group of employees, humidity has less effect and dry bulb temperature more effect on their feeling of comfort than is shown by the effective temperature relationship.

Comfort Not Affected by Humidity Change

A study of Figs. 6 through 9 showing the variation of percentages of the employees feeling cool, ideally comfortable and warm for a constant dry bulb temperature indicates that there is no appreciable change in the percentages as the relative humidity increases. This indicates that within the limited range of relative humidities investigated, 35 to 60 per cent, the employees studied felt no appreciable change in comfort with a change of humidity at a constant dry bulb temperature.

The seeming lack of any humidity effect on the feeling of warmth is in direct contradiction to the effective temperature concept and could be ascribed partly to inherent limitations of the effective temperature index and partly to the many factors entering into an individual's feeling of warmth; factors which could be controlled in the laboratory but not in a business office. Some of these factors are solar radiation, health of the individual, drafts, attitude toward the test, and variation in the amount of clothing worn from day to day.

In order to check the effects of these factors, several charts were plotted, each recording all of the votes cast by various persons who were chosen at random. These charts were plotted with relative humidity as ordinate and with dry bulb temperature as abscissa. The

typical chart is shown in Fig. 10. The three diagonal lines represent effective temperatures of 66, 71 and 75 deg, which are given in the effective temperature scale as the minimum, optimum, and maximum effective temperatures for summer comfort. These figures show that there was a wide variation in the attitude and reactions as obtained from the individual records.

The individual whose votes are shown in Fig. 10 was a woman under 20 years of age. The record of her daily votes indicates little consistency, showing ideal votes throughout the range of conditions and also cool and warm votes scattered seemingly indiscriminately throughout most of the range. Further study of this individual failed to show any ascertainable correlation between her feeling of warmth and other factors except that the votes cast during the morning were slightly more consistent than those cast in the afternoon. It was thought that possibly one factor here might be the effect of solar radiation, inasmuch as this person was located in the northwest corner of the building directly inside the western exposure windows.

Taken together, the charts of individual votes show clearly that there was little correlation in the feelings of warmth between one person and another and, in some cases, little correlation between the feelings of warmth and condition of temperature and relative humidity for one person.

A further question arose during the study of individual reactions when it was found that the total number of votes varied widely from person to person, ranging from eight to ninety among the individuals studied.

The effect of this variation could not be ascertained, but whether due to incomplete polling or to some other factor, it could possibly cause serious errors in the results obtained.

Based on an analysis of the reactions of selected individuals, the graphs showing the average reactions of the entire group take on a new meaning. As averages, they

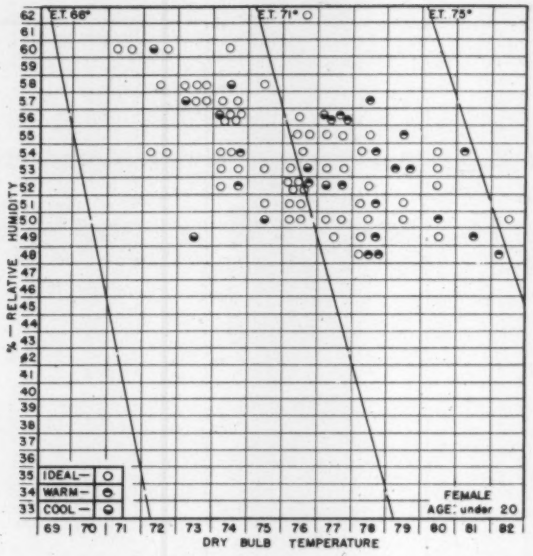

Fig. 10—Person "G"

reflect the conglomerate effect of individuals of different temperament and varying degrees of consistency and cooperation. While this study indicates that there was no apparent effect of humidity on comfort for this office and group of employees, the question arises as to whether or not the same relationship would hold true in another office with a different group of employees.

Conclusions

With these limitations emphasized, the general conclusions to be drawn from this study of effective temperature are as follows:

1. For this office and particular group of employees and in the limited range of conditions studied, variations of relative humidity between 35 and 60 per cent caused no appreciable effect in the feeling of comfort.
2. The maximum percentage of subjects indicating comfort occurred at a dry bulb temperature of about 74 F regardless of humidity (68.5 to 70.5 deg ET). Seventy per cent of the employees were included in this group.
3. The lack of any humidity effect on the feeling of warmth is in direct contradiction to the effective temperature concept and could be ascribed partly to inherent limitations of the effective temperature index and partly to the many factors entering into an individual's feeling of warmth which could be controlled in the laboratory, but not in a business office.
4. It is recommended that laboratory experiments be undertaken for the purpose of confirming or discrediting the disputed humidity effect within the zones of comfort and for lower temperatures.

It is emphasized that the results of this study are based upon a limited range of temperature and humidity and that a considerable period of time elapsed between the taking of the data and the analysis of the data. Furthermore, the original data were not taken by the authors and were not taken with the present analysis specifically in view. While it does appear that the effective temperature scale needs revision, it is not recommended that this report be used as the basis for that revision. It is felt that the results presented herein are not in themselves conclusive evidence and should not be taken as other than indicative of some need for a revision based upon more complete information.

PANEL INSTALLATION COSTS

During the Panel and Radiant Heating Forum discussion at Cleveland, Ohio, P. S. Park, Pittsburgh, Pa., stated that: "On the basis of my wide experience with engineers and contractors, I should like to state in fairness to both systems that I have found a variance of opinion, but in the majority of cases installation costs favor the floor system." This was incorrectly quoted on page 111 of the April issue of ASHVE JOURNAL SECTION and we are glad to publish this correction.

Conditions for Comfort

By Charles S. Leopold*, Philadelphia, Pa.

SUMMARY—Comfort is defined as the absence of discomfort or annoyance due to temperature and atmospheric effects indoors. A thermostat setting of 75 F has been found to meet the summer and winter comfort requirements of occupants in a number of large office buildings where thermostats are set by either the occupant or by the custodian. With the 75 F setting, the relative humidity is varied from approximately 30 per cent in winter to 50 per cent in summer.

A *discomfort* chart is presented to facilitate evaluation of maintained conditions.

Distinction is made between optimum comfort for an individual and for a group.

THERE are many definitions of comfort but the one chosen for this discussion is: The absence of discomfort or annoyances due to temperature and atmospheric effects indoors. Neither considerations of health, deliberate stimulation or lowering of activity are primary factors in optimum comfort or minimum discomfort as thus defined.

For rooms of multiple occupancy, and particularly for desk work, it follows that the optimum conditions are those in which the occupants are not conscious of discomforts or annoyances due to temperature and atmosphere. This definition would include the effects of radiation, air temperature, water vapor, odor, and air motion. Active conditions such as *comfortably warm* and *comfortably cool* are not acceptable to a group.

For actual installations, the criterion should be: What conditions are acceptable to the greatest number who do not have to pay for the maintenance of these conditions and who are unaware that a test is being conducted? For house heating, if the master of the house must pay a high fuel bill, he quite likely will find an *optimum* which compromises with his pocketbook. His guests will be just plain cold. In any building, if the subjects know that a test is being conducted, they tend to interpret their sensations and are likely to report what they think they should feel. Many people seem to believe it is a virtue to endure cold indoors.

There are two buildings of massive construction in Washington in which air conditioning was installed about ten years ago. In each, air is supplied by large systems, and the final control for each room is obtained by reheat controlled by a thermostat with a temptingly large adjusting knob. The moisture of the conditioned air is controlled to give approximately 50 per cent relative humidity in summer and 30 per cent relative humidity in winter. The total occupancy (ages 18 to 80) is over 2000. Air motion is moderate. One building has radiators beneath the windows; the other depends on the air system for all heating requirements.

A census of the control setting at any time, summer or winter, will show upwards of 90 per cent of the room thermostats set for 75 F to 76 F and maintaining 74 F to 77 F.

A large office building, also near Washington, has a population of 25,000 to 35,000. A thermostat setting of about 75 F appears to be the best for both interior and exterior zones year-round.

An insurance building in the middle west, with approximately 1000 employees, operates at about 76 F, summer and winter. The radiation, due to convection through walls and windows, is balanced at the wall. In this case the higher temperature is probably required because the cooling air is uniformly introduced through a perforated ceiling, which results in a year-round lower mean radiant temperature of the room.

Two large office buildings in Texas operate at approximately 77 F throughout the year. These buildings have complete zone control and are extensively sub-divided. The desire for slightly higher temperature is probably due, in part, to acclimatization and, in part, to working slightly on the warm side to compensate for the absence of individual controls in small offices.

In all but the first example, conditions were finally set by the operating engineer faced with the problem of satisfying the most people. In the first example they are set by the occupants themselves.

Mass determinations, such as the foregoing, lack the accuracy of well conducted laboratory experiments but they have the great virtue of numbers and the absence of conscious psychological factors or systematic errors due to the employment of a few *trained* subjects.

The thought that an appreciable percentage of people will be dissatisfied regardless of conditions is not supported by observation of

*Consulting Engineer. Member of ASHVE.

Presented at the Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Coronado, Calif., June 1947.

systems properly designed and operated. In drawing conclusions from field experience, however, it is advisable to exclude from the data systems in which:

1. The draft problem has not been thoroughly solved.
2. There are pronounced unbalanced radiant effects.
3. Constant conditions cannot be maintained throughout the day because of limited capacity.

If laboratory work does not agree with the mass experience, we should then question either:

1. The laboratory technique, or
2. The mental process whereby the results of the laboratory are applied to every-day living.

The AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, for many years, has contributed valuable laboratory data on this subject. Unfortunately, the ASHVE Comfort Chart, rather than the valuable and voluminous ASHVE publications, is the major contact with many engineers.

Fig. 1 shows the chart as originally published in 1929. It contains ASHVE laboratory data as found, plus a concept of a *comfort zone.* The indicated zone included all conditions from a maximum to zero per cent comfortable and, therefore, had a definite meaning as it indicated the total range of conditions in which some people were comfortable. This chart confirms the summer optimum of approximately 76 F and 50 per cent relative humidity but does not agree as to winter optimum. The optimum condition is somewhat subject to seasonal acclimatization which tends to explain geographical deviation. In general, the latter appears to be a rather small effect.

Fig. 2, published in 1932, stresses and redefines the *comfort zone* to the area bounded by 30 per cent and 70 per cent relative humidity, and to 50 per cent of the subjects comfortable on the cool side and 50 per cent of the subjects comfortable on the warm side. This zone is purely arbitrary. Certainly, a condition in which 50 per cent of the people are uncomfortable is a poor type of comfort. In producing this chart, the scale showing the per cent of people uncomfortable was omitted, thus tending to obscure the fallacy of the concept. The *comfort zone,* as here defined, did great service as propaganda but was a poor engineering approach since it tended to obscure the real problem.

In order to have a simpler form of presentation, the *discomfort* chart was prepared by the author in 1938 (Fig. 3). Plot of the winter data immediately indicated a very unlikely form of graph for statistical data on physiological response as it would not be expected that a large number of subjects would go precipitously from comfort to cold on a drop of one or two degrees. A graph, such as that shown for summer, is more logical as this graph closely approximates a probability curve.

This questionable curve could result from experimental technique or from subjects themselves trying to interpret the data. Fortunately, experiments [1] conducted by the same laboratory in 1941 showed that the optimum effective temperature was approximately 67.5 ET (Effective Temperature) instead of the 66 ET of earlier experiments. At 67.5 ET, this would mean a winter temperature at 30 per cent RH (relative humidity) of 74 F, instead of 72 F shown on comfort charts, and is in substantial accord with the field observations previously stated. In actual installations, temperatures tend toward the high side as people who are too cool appear more annoyed than people too warm. If an attempt is made to account for the shift in desirable winter effective temperature by a mass change due to acclimatization, we are still confronted with our inability to explain the improbable shape of the original curve, other than by belief in the virtue of enduring cold indoors.

Some experimenters have used the words *pleasant* and *unpleasant* to denote the opinion of the test

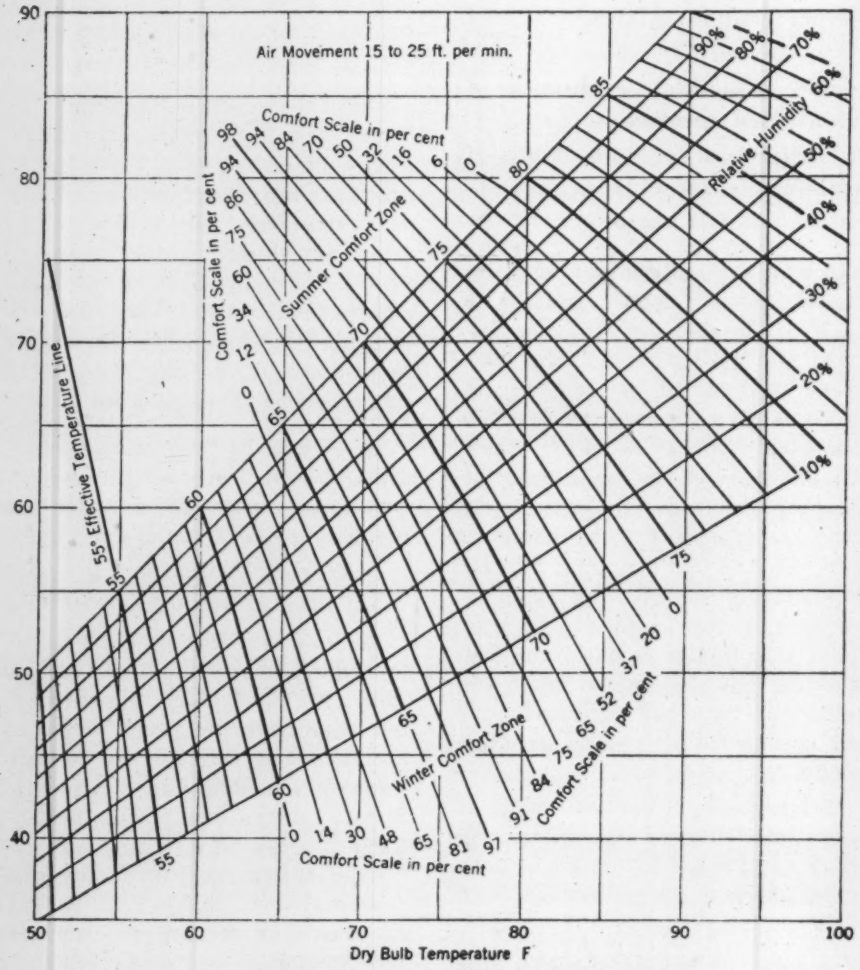

Fig. 1—Original ASHVE Comfort Chart (1929)

[1] ASHVE RESEARCH REPORT NO. 1172—Radiation as a Factor in the Sensation of Warmth, by F. C. Houghten, S. P. Gunst and J. Suciu, Jr. (ASHVE TRANSACTIONS, Vol. 47, 1941, p. 93.)

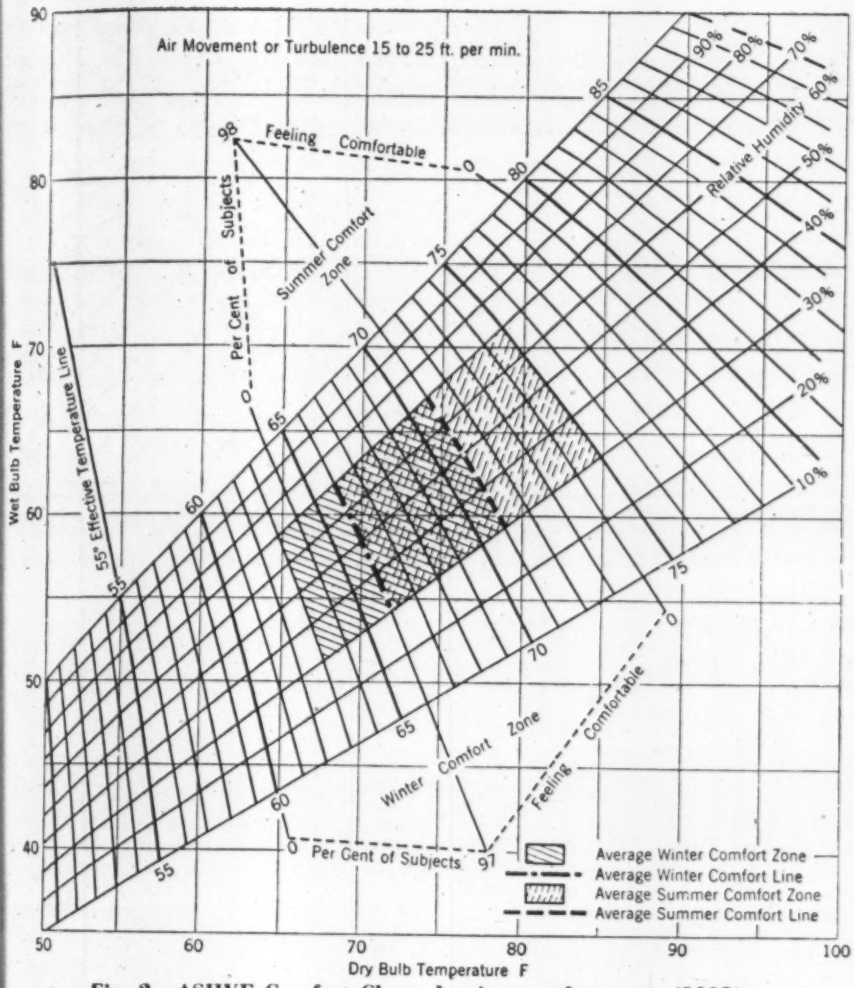

Fig. 2—ASHVE Comfort Chart showing comfort zone (1932)

subjects. It is frequently pleasant to be stimulated or calmed but neither condition is necessary to optimum comfort of a group.

The revised discomfort chart, (Fig. 4) prepared by the author in 1943, indicates the new winter data. Only a portion of the winter line is shown as data for the complete line are lacking.

The comfort chart, Fig. 5, from the HEATING, VENTILATING, AIR CONDITIONING GUIDE 1946 has added curves showing the distribution of comfort but still retains the comfort zone with limits of 30 to 70 per cent RH, and the winter line in accordance with the 1929 data. The text, however, calls attention to the fact that the 1929 winter data are not supported by later tests and that the 30 to 70 per cent limit on relative humidity has inadequate experimental support.

Fortunately, the substantial agreement of field and the ASHVE Laboratory tests provide a firm basis for design. Control is rendered relatively easy as, in many

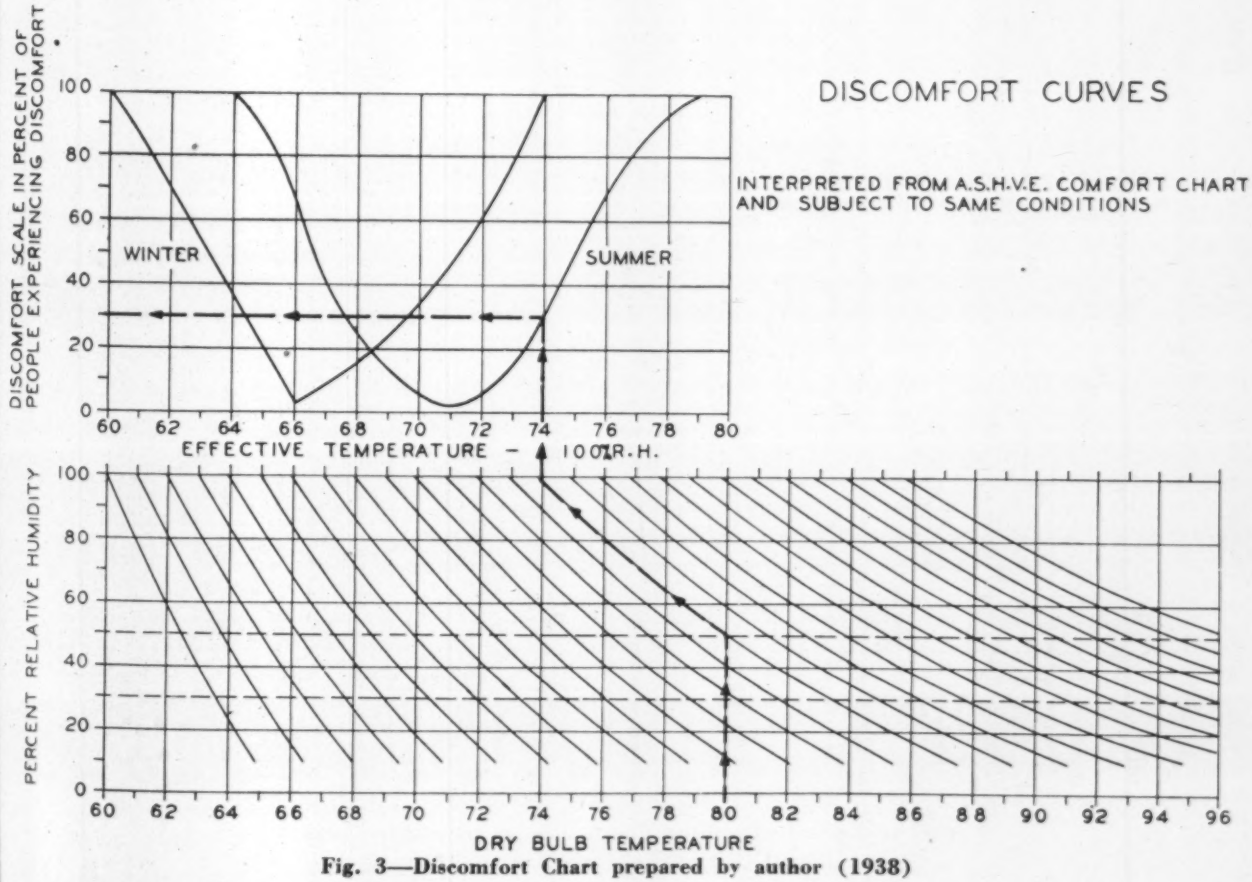
DISCOMFORT CURVES
INTERPRETED FROM A.S.H.V.E. COMFORT CHART AND SUBJECT TO SAME CONDITIONS
DISCOMFORT SCALE IN PERCENT OF PEOPLE EXPERIENCING DISCOMFORT
WINTER
SUMMER
EFFECTIVE TEMPERATURE — @ 100% R.H.
PERCENT RELATIVE HUMIDITY
DRY BULB TEMPERATURE

Fig. 3—Discomfort Chart prepared by author (1938)

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cases, it is unnecessary to change thermostat settings throughout the year. For example, a room with outside exposure will tend to drift above thermostat setting in summer and below in winter. Thus, a setting of 75 F will substantially span the 74-76.5 F required, as shown by the line on Fig. 4 connecting 74 F, 30 per cent relative humidity with 76.5 F, 50 per cent RH.

The foregoing discussion pertains to building occupants above 17 years of age and is further limited to a relative humidity range of 25 to 55 per cent. The vast majority of office building applications fall within these limits. The effect of relative humidity on discomfort, shown by ASHVE tests at other than optimum conditions, is neither questioned nor affirmed.

Experiments[2] (1941) show that a change of about 6 deg ET (approximately 7.5 deg DB) is required for one individual to go from *comfortably cool* to *comfortably warm*, or vice versa. Why, then,

[2]Loc. Cit. See Note 1.

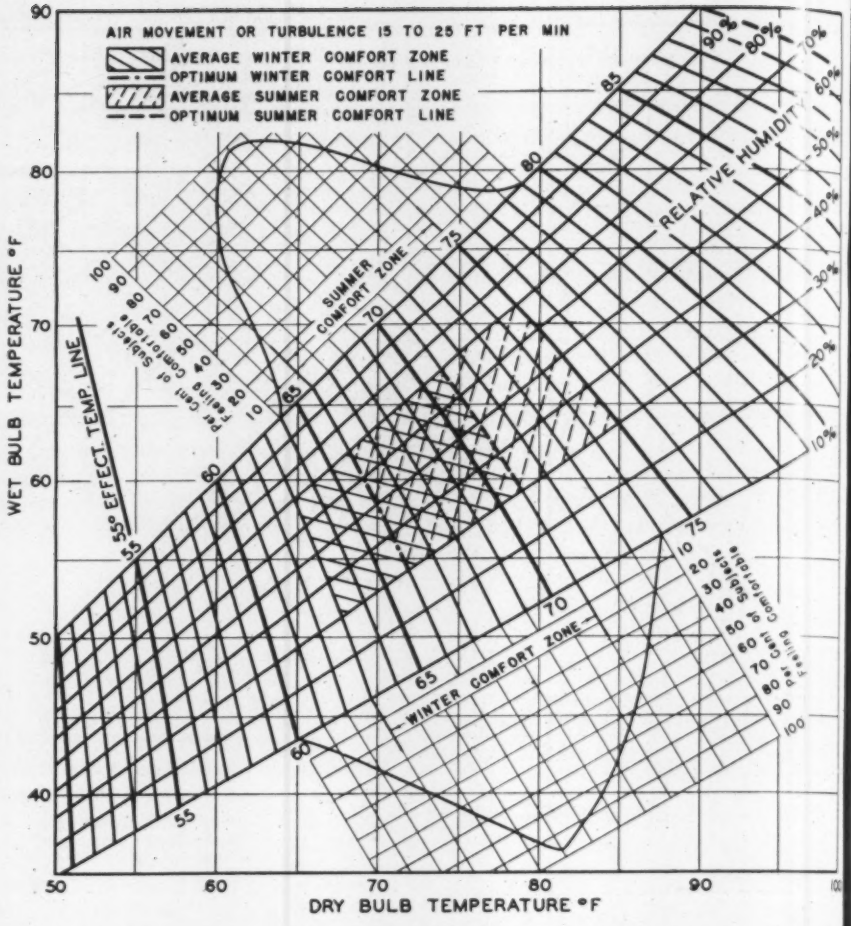
AIR MOVEMENT OR TURBULENCE 15 TO 25 FT PER MIN
AVERAGE WINTER COMFORT ZONE
OPTIMUM WINTER COMFORT LINE
AVERAGE SUMMER COMFORT ZONE
OPTIMUM SUMMER COMFORT LINE
WET BULB TEMPERATURE °F
DRY BULB TEMPERATURE °F
RELATIVE HUMIDITY
55° EFFECT. TEMP. LINE
SUMMER COMFORT ZONE
WINTER COMFORT ZONE
Per Cent of Subjects Feeling Comfortable

Fig. 5—Comfort Chart from Heating, Ventilating, Air Conditioning Guide 1946

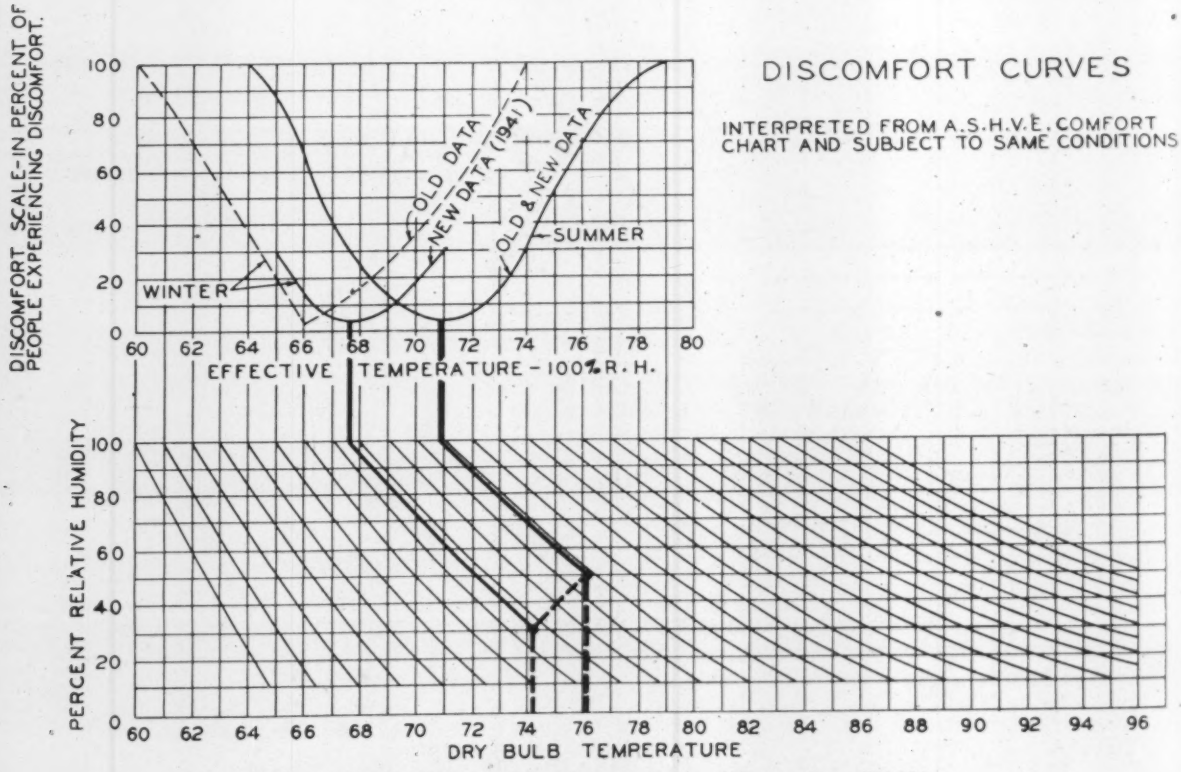

Fig. 4—Revised Discomfort Chart prepared by author (1943)
(Based on ASHVE Research—1941)

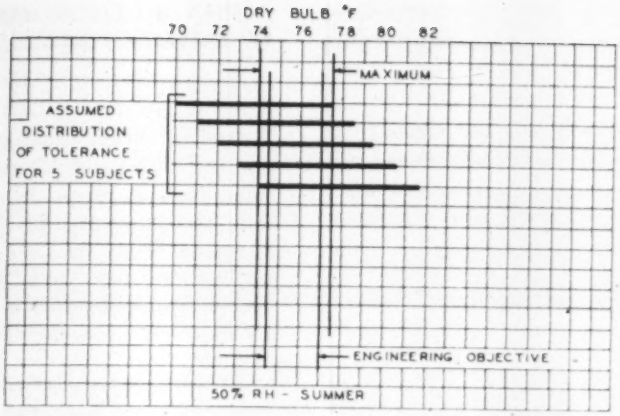

Fig. 6—Illustration of relation of group to individual tolerance

the need for such accurate control? First, one individual cannot be warm or cool if he wishes to remain unaware of atmospheric and temperature conditions as the slightest change in air motion or temperature would be noticeable and, second, we are usually dealing with more than one person.

Assume that for five subjects the extreme range of temperature is 70, 71, 72, 73, and 74, respectively, in each case, plus 7.5 deg. Graphing these results, as in Fig. 6, shows that the range 74-77.5 F lies within the theoretical tolerance for all subjects but that for safe design the acceptable band would be 74.5 to 77 F. The figures are not intended to represent a known distribution of temperature tolerance but only to illustrate how a reasonable tolerance of an individual will still necessitate a very close tolerance for a group.

Are the optimum conditions herein outlined good or bad from the health angle? No published data of the author's admittedly limited knowledge casts any reasonable doubt as to their being satisfactory, especially as the human animal is adapted to and, on a normal day, is exposed to considerable variation in temperature.

An inspection of Fig. 7 from THE GUIDE 1946, to which has been added the recommended temperature range of 74.5 to 77 F, fails to indicate any danger point. For the lightly clothed semi-reclining subjects of the Pierce Laboratory[3] experiment, the point of no heat storage occurs at approximately 77.5 F, and for the normally clothed subject of the ASHVE tests, there is a considerable range of no storage (The difference between lines which show metabolism and total heat loss). The selected limits fall in a range of satisfactory evaporative regulation.

The conclusion would appear to be that the designated limits are approximately right for comfort and there would be no reason to deviate unless and until it could be demonstrated that people should be made uncomfortable for the good of their health. The burden of proof is on the advocates of low winter and high summer indoor temperatures.

Buildings in general, office buildings in particular, are conditioned in order that the occupants may work without the discomforts due to temperature and atmosphere. Conditioning such a space provides more pleasant living and, as such, is one of many considerations in the complex employer-employee relationship. This phase may be the major consideration.

In an office building with adequate windows, in the absence of air conditioning employees tend to blame nature for their discomforts but the moment it is air conditioned and the windows closed, management assumes responsibility. With an adequate conditioning system they should reach their objectives of good employee-employer relationship; with an inadequate system they may not only fail to gain good will but may actually incur ill will. There would appear to be little justification for an installation which appreciably compromises with optimum results as to comfort conditions.

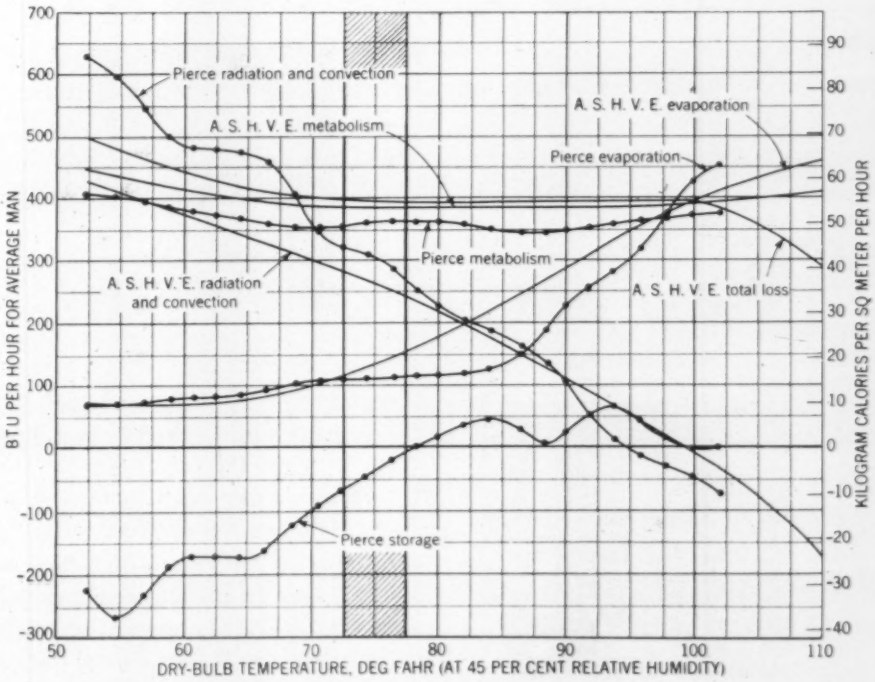

Fig. 7—Relation between metabolism, storage, evaporation, radiation plus convection and operative temperature for the clothed subject

[3] ASHVE RESEARCH REPORT No 1107—Recent Advances in Physiological Knowledge and Their Bearing on Ventilation Practice, by C.-E. A. Winslow, Thomas Bedford, E. F. DuBois, R. W. Keeton, André Missenard, R. R. Sayers and Cyril Tasker. (ASHVE TRANSACTIONS, Vol. 45, 1939, p. 111.)

PROFS. QUEER AND McLAUGHLIN AS CONSULTANTS

E. R. Queer and E. R. McLaughlin, professor and assistant professor at Pennsylvania State College, and authors of numerous technical papers, have been retained by the Pittsburgh Lectrodryer Corp. as consulting engineers.

Both men hold B.S. and M.S. degrees from Pennsylvania State College, Professor Queer in electrical engineering, and Professor McLaughlin in mechanical engineering.

Upon graduating, Professor Queer joined the staff of Pennsylvania State College as an instructor in engineering research. His association with the college was interrupted by the 2nd World War, in which he served as a Lieutenant (J.G.) USNR, and at the time of his discharge held the rank of Commander. During his service with the navy, Professor Queer was in charge of the development of dehumidification procedures and equipment for the preservation of the inactive fleets in the post-war Navy. He received commendations from both Admiral Nimitz and the Secretary of War.

He was appointed to his present post as professor of engineering research in charge of the thermal research laboratory, Pennsylvania State College, in August, 1946, upon his return to civilian life.

An ASHVE member since 1933, he is serving as chairman of the 1947 Research Technical Advisory Committee on Insulation. Professor Queer also holds membership in the *Society of Naval Architects and Marine Engineers*, Sigma Xi, and is an associate in the U. S. Naval Institute and the U. S. Naval Reserve.

Professor McLaughlin has been associated with the faculty of Pennsylvania State College since 1939, receiving an appointment as an instructor in 1941 and assistant professor of engineering research in 1945. He is a member of Sigma Xi, the *American Association of University Professors*, and is currently serving as a member of the Society's Research Technical Advisory Committee on Sorbents.

E. R. Queer

E. R. McLaughlin

HACKETT PROMOTED BY BELL & GOSSETT

The appointment of Frank C. Hackett, an associate member of the Society since 1940, as sales promotion manager was announced by Ralph A. Patterson, general sales manager, Bell & Gossett Co. One of his new duties will be conducting the educational program on modern heating now being developed by the company.

Mr. Hackett has done an outstanding job in working with various government agencies, and during the past thirteen years he has been in charge of an eastern sales territory for Bell & Gossett.

Prior to joining the Bell & Gossett Co. he received a well rounded experience in his association with the Ames Iron Works, Pierce Butler Radiator Corp., and Construction Code Authority, Washington, D. C.

F. C. Hackett

ALFRED J. OFFNER MEMBER OF INTERNATIONAL JURY

Among the recent visitors to the Turkish capital of Ankara was Alfred J. Offner, past president of the ASHVE and consulting engineer, New York, N. Y. Mr. Offner, who was impressed by Ankara as a clean, modern city, is a member of an international jury judging the mechanical plans for a new group of buildings for the Turkish parliament.

When completed, this group, formed by over ten interconnected units, will contain four large legislative meeting rooms, one of which is said to be the largest in the world. Associated with him in the judging of mechanical plans for these buildings are: Prof. Henri Quiby, Federal Technical College, Zurich, Switzerland, and Dr. Oscar Faber, consulting engineer, London, England.

Mr. Offner is well equipped for his present task, since he has planned the mechanical equipment for many public and private buildings located in various parts of the United States, Europe, South America and Asia. He received his B.S. and an M.E. from Cooper Union, where he later taught advanced physics for five years, and has been head of his own consulting firm since 1930.

In addition to being president of the ASHVE during 1946-1947, he has served as vice president, treasurer, chairman of many important committees, and as a member of the Council since 1935. He was president of the New York Chapter during 1930. Mr. Offner is also a member of the New York *Association of Consulting Engineers*, serving as its president in 1930-31.

Mr. Offner spent a few days in Cairo, Egypt, where he visited with several of the Society members.

A. J. Offner

PAUL ADDAMS ELECTED PRESIDENT FITZGIBBONS

Announcement was made by Homer Addams on May 12, 1947, of the election of Paul K. Addams as president of the Fitzgibbons Boiler Co., Inc., New York, N. Y. Homer Addams retires as president but retains his position as Chairman of the Board. Homer Addams is a Charter Member, Life Member, past president and treasurer of the ASHVE.

Other officers elected were John A. Darts, executive vice president, a member of the ASHVE since 1919, and R. C. Malvin, vice president, also a member of the ASHVE. All other officers were reelected to their respective positions including: James F. Swartz, secretary; G. E. Olsen, also a member of ASHVE, vice president, metropolitan sales; and George J. Kuney, assistant treasurer.

Paul Addams joined the staff of Fitzgibbons in 1929, following his graduation from the Wharton School of Finance and Commerce, University of Pennsylvania, Philadelphia, Pa. For the first few years he devoted his time to manufacturing activities and personnel relations at the plant in Oswego, N. Y., and in 1931 he was assigned to the general offices in New York as assistant to Raymond Newcomb, sales manager. At Mr. Newcomb's death in 1932, Mr. Addams assumed the full duties of the office and in 1936 he became executive vice president and treasurer as well as a director of the corporation. In 1943 he was made chairman of the executive committee.

Mr. Addams became a member of the ASHVE in 1943 and is an active member of the New York Chapter. He is also a member of the executive committee and chairman of the sales and distribution committee of the *Steel Boiler Institute*, as well as a director of the *Oil-Heat Institute* and a member of that organization's planning committee and vice chairman of its Accessories Division.

Mr. Addams belongs to the Engineers' Club, Union League Club and the University of Pennsylvania Club of New York, of which he is treasurer and a member of the council.

P. K. Addams

F. P. BLEIER OPENS CONSULTING OFFICE

Frank P. Bleier, formerly director of research and development for the Ilg Electric Ventilating Co., has established his own consulting offices at 547 West Addison St., Chicago, Ill.

Mr. Bleier, an industrial physicist and widely known mathematical designer of air moving equipment, will serve as designer to manufacturers of fans, blowers and compressors of both axial and centrifugal types.

A native of Vienna, Austria, Mr. Bleier received his engineering degree at the Technical University of Vienna. Prior to joining the Ilg Electric Ventilating Co., in 1942, he was connected for a short time with the Société Lyonnaise de Ventilation, France, and the American Machine & Metals, Inc., Moline, Ill.

Mr. Bleier, joined the ASHVE in 1944 as an Associate, advancing to full membership in 1945. He has published many technical papers in the field of fan and blower design.

F. P. Bleier

NUTTING AND POUND RECEIVE PROMOTIONS

Arthur Nutting and Howard W. Pound, prominent figures in ASHVE activities and the air filtration field, have been appointed vice presidents of the American Air Filter Co., Inc., as announced by the company's president, W. M. Reed.

Mr. Nutting is a graduate of the University of Kentucky, receiving his B.S. in mechanical engineering in 1926. Previous to joining the American Air Filter Co., Inc., he had been affiliated with the Reed Air Filter Co., as a design engineer. Since 1937, until his recent appointment, Mr. Nutting had been in charge of the American Air Filter Company's engineering and research programs as chief engineer, aiding in the development of many air filtration and dust control devices. Mr. Nutting has been a member of the Society for nine years and served as a member of the Air Filter Test Code Committee in 1938.

After serving in the 1st World War as a naval aviator, Mr. Pound graduated from Purdue University in 1921 with a B.S. degree in mechanical engineering. He had been associated with the Independent Air Filter Co., where he developed an electrostatic filter prior to 1939, when he joined the American Air Filter Co., Inc., as sales manager of the air filter sales division, a position which he held until his present appointment. In addition to being an ASHVE member since

Arthur Nutting

H. W. Pound

1941, Mr. Pound is a 32nd Degree Mason and a member of the Shrine Kosair Temple.

DENNIS BOGGS APPOINTED CHIEF ENGINEER

The appointment of Dennis Boggs as chief engineer of the Avery Engineering Co., Cleveland, Ohio, was announced by Lester T. Avery, president of the company. His new duties will include the supervision of all engineering pertaining to refrigeration and air conditioning contracts.

Dennis Boggs

A native of Whitesburg, Ky., Mr. Boggs received his engineering degree from the University of Kentucky in 1936. Prior to joining the Avery Engineering Co., in 1942, he was employed for three years by the Horten-Knodd Dist. Co., as an application engineer, and the Sweeney-Graham Engineering Co., as an air conditioning engineer.

Mr. Boggs became a member of the ASHVE in 1943, and also holds membership in the *ASRE*.

R. C. CUSHING IN NEW POST

Reginald C. Cushing has been appointed sales manager of the air conditioning controls division for the Pacific region of the Minneapolis-Honeywell Regulator Co., with offices at 1136 Howard St., San Francisco, Calif., as announced by J. S. Locke, Minneapolis, manager of the division.

Mr. Cushing, a member of the Society for a number of years, joined the staff of Minneapolis-Honeywell in 1935 and during the war he worked closely with the U. S. Army in the design and installation of aircraft engine test cells.

SAMUEL GOODWIN, LIFE MEMBER, DIES

Samuel L. Goodwin, life member of the ASHVE since 1943, died on April 7, 1947, in his 74th year.

Mr. Goodwin was born in Worcester, Mass., where he received his preparatory education. In 1902 he began his five year course of study in architecture with the New York Society of Beaux Arts.

His extensive professional experience included 30 years' work with large New York architectural offices, during which time he was in constant touch with every branch of mechanical engineering affiliated with architecture. For many years he was connected with T. W. Lamb, New York, N. Y., working exclusively on sanitary, heating and ventilating engineering. His last position was with the architectural firm of John & Drew Eberson, New York, N. Y., as consulting engineer.

Mr. Goodwin designed the heating and ventilation systems of many important buildings. These include several of the Loew's Theaters throughout the country, Fox's Philadelphia Theater and office building, the Crandall Residence and Grace Dodge Hotel, Washington, D. C.

To his widow and family, and also to his many friends, the Officers and Council of the Society extend their deepest sympathy.

T. F. STEINHORST DIES

T. F. Steinhorst, president of Emil Steinhorst & Sons, Inc. passed away on March 10, 1947, after a two weeks illness. He had been a prominent member of the Central New York Chapter and a member of the Society since 1919.

Mr. Steinhorst was born in Utica, N. Y., on July 5, 1888. He received his education at the Advanced and Utica School of Commerce.

His entire professional career was spent with Emil Steinhorst & Sons, Inc., which his father had started as a business dealing in warm air heating equipment. Under the management of Mr. Steinhorst it has turned to the manufacture of cooling and quick freezing apparatus. One of his first positions in this firm was as an estimator and superintendent. In this capacity he planned the heating, ventilating, exhaust and drying systems for schools, dwellings, and factories. He became treasurer in 1920, and president in 1934 upon his father's death.

In addition to his activities in the ASHVE, Mr. Steinhorst was a Mason and was connected with the Kiwanis Club, Utica Chamber of Commerce, and the Lutheran Church. He was also director of the Utica Fire Insurance Co., and vice president of the Home Savings & Loan Association.

He is survived by his widow, Mrs. Emma Steinhorst, two daughters, a sister, and six brothers who were his associates in business, to whom the Officers and Council extend their deepest sympathy.

H. S. HAMILTON PASSES AWAY

Word was received recently of the sudden death on March 22, 1947, of Howard S. Hamilton, an active member of the Wisconsin chapter and a member of the ASHVE since 1940.

Born in Milwaukee on July 5, 1881, Mr. Hamilton attended public schools in Milwaukee and the Black Hall School, Black Hall, Conn.

Prior to 1931, when he entered the refrigeration and air conditioning field, Mr. Hamilton had been manager of several automobile concerns in New York. For several years he was engaged in publicity work for the manufacturers of Panhard and Levassor automobiles, traveling extensively in Europe.

Between 1931 and 1938 he acted as Milwaukee representative for the E. H. Schaefer Co., Frigidaire and Kelvinator distributors. In 1938 he and a partner formed the Air Correction Co., dealing in unit devices for correcting improper air conditions in offices and homes. He entered the Milwaukee district office of the U. S. Army as administrative assistant to the Chief of Military Supply in 1941. Later he was transferred to the readjustment branch as a special expediter.

Mr. Hamilton was active in many civic organizations and had been treasurer of the *Automobile Importers Association*, New York.

The Officers and Council of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS join the Wisconsin Chapter in expressing sympathy for the loss of a valued member.

Summary of Local Chapter Meetings*

ATLANTA — April 4, 1947. Subject: Reverse Cycle Residential Heating. Speaker: Marvin Smith, vice president, Muncie Gear Works, Muncie, Ind. A discussion period followed Mr. Smith's interesting talk. Other Features: H. King McCain introduced Donald V. H. Smith, consulting engineer, London, who gave a short talk on conditions in England. Lewis Barnes reported that a total of $412.00 had been accumulated for the fund to reduce the mortgage on the Research Laboratory. A report on the program for the May meeting was given by W. W. Carder. Attendance 58. Attendance ratio 0.57.

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CENTRAL NEW YORK—April 16, 1947. Annual Business Meeting. Members reviewed events and programs of the past year with the object of offering constructive criticism toward the planning of future meetings. The reports of the treasurer, finance committee chairman, and the secretary were read and approved. A report of the chairman on public relations showed that there is a good press coverage of the meetings. The chairman of the membership committee reported on the growing membership. C. M. Ashley gave a brief talk on the methods by which the Society operates, and the part which members and local chapters may have in directing its policies. He also spoke about the work at the Society's Research Laboratory. A report on the chapter delegates meeting at the Annual Meeting of the ASHVE was given by H. Kingsley Ormsby, Jr. These talks promoted a worthwhile discussion in which everyone had an opportunity to voice an opinion on local and national affairs of the Society. The new officers elected for the coming year are: H. G. Strong, *president*; D. L. Mills, *vice president*; J. H. Carpenter, *treasurer*; G. F. Keane, *secretary*; C. F. Woese, F. L. Manier, and H. K. Ormsby, Jr., *board of governors*. Attendance 21.

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CENTRAL OHIO—April 21, 1947. Subject: Production and Utilization of Coal in Japan. Speaker: W. T. Reid, fuels division, Battelle Memorial Institute. Mr. Reid used slides and photographs of Japanese coal processing plants to illustrate the data presented. Kodachrome slides showing contemporary Japanese life, and the effect of the war-time bombings and fires, were another feature of this interesting presentation. Other Features: The following candidates were elected to hold office in the coming year: *President*, R. B. Breneman; *Vice President*, W. M. Myler, Jr.; *Secretary*, E. A. Norman, Jr.; *Treasurer*, A. P. Potts; *Board of Governors*, Arthur T. English, Newton T. Hess, and H. R. Allonier. Attendance 34. Attendance ratio 0.34.

CENTRAL OHIO—March 17, 1947. Subject: Heat Transfer to and from Direct Fired Heating Surfaces. Speaker: Prof. Lorin G. Miller, head, mechanical engineering department, Michigan State College, East Lansing, Mich. In his talk, Professor Miller reviewed the methods of transferring heat through materials and the laws that govern the rate of this transfer, after which he showed slides illustrating how much greater the heat transfer was when surfaces were operated close to the temperatures at which they begin to scale. By taking advantage of this increased rate, he showed how it was possible to design a furnace of minimum size without sacrificing durability. Professor Miller handled his difficult and highly technical subject in an interesting manner, and considerable discussion followed his presentation. Other Features: A committee composed of Messrs. Julian Speer, Arthur Wollerman and T. R. Walker was elected to nominate new officers. Attendance 50. Attendance ratio 0.40.

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DELTA—April 8, 1947. Subject: Coordination Between Architects, Engineers and Contractors. Speaker: M. M. Maxwell, Secretary, Louisiana chapter of the *American Institute of Architects*. A lively discussion followed Mr. Maxwell's interesting talk. Other Features: A letter from Mrs. John Devlin acknowledging the Delta chapter's testimonial to the memory of her late husband, John Devlin, was read and incorporated in the minutes of the meeting. A motion was carried that a committee be appointed to study the question of securing student membership from Tulane University. G. E. May gave a report on the proposed revision to the local building code. Attendance 21.

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GOLDEN GATE—April 3, 1947. Subject: Air Conditioning Requirements for Buildings. Speaker: C. L. Ringquist, The Trane Co., La Crosse, Wis. Mr. Ringquist devoted part of his talk to outlining the development and application of the system for multi-story and multi-room buildings. Following the talk, Mr. Ringquist answered many questions from the floor. Other Features: A report was given on the fourth annual meeting of the Oregon Chapter by John Everetts, Jr., who stated that the Oregon Chapter was doing an outstanding job. The following recommendations for officers were submitted: President,

*Note: The attendance ratios shown represent the membership attendance divided by the chapter membership. These ratios will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by the various chapters and may be useful in deciding on subjects for chapter meetings.

Fred Kolb; Vice President, H. V. Hickman; Secretary, K. B. Baldwin, Jr.; Treasurer, R. C. Cushing; Board of Governors, H. G. Smith, Paul Babcock and John Everetts, Jr. The question of the proposed licensing law for engineers was brought up; also the advisability of holding a June meeting, which would conflict with the Semi-Annual Meeting at Coronado. Attendance 83. Attendance ratio 0.48.

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ILLINOIS—April 14, 1947. Subject: Technology Tomorrow. Speaker: Dr. Baldwin M. Woods, president of the ASHVE and director, University Extension, University of California, Berkeley, Calif. In his exceptionally well presented talk, Dr. Woods reviewed the technologic developments of the past and indicated possibilities for the future. The chapter was further honored by having as its guests several members of the Society's Council, A. V. Hutchinson, secretary, Cyril Tasker, director of research, and Past Presidents John Howatt, S. R. Lewis, and Dr. E. V. Hill.

Mr. Lewis spoke briefly on the organization of the chapter in 1906 and showed a photograph, taken at that time, which everyone found of interest. Other Features: The treasurer reported on the favorable effort made by the Illinois chapter to assist in reducing the mortgage on the Research Laboratory building. The chairman of the meetings committee announced that the May meeting would be devoted to installation of new officers and entertainment. Attendance 100.

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INDIANA—March 28, 1947. Subject: Purdue University Bleacher Collapse. Speaker: Bert Westover, director, Administrative Building Council of the state of Indiana. Mr. Westover prefaced his talk with a brief outline of the status and activities of his department. He then went into the report of the investigating committee on the Purdue University bleacher collapse, giving a detailed and interesting account of the findings of this committee, of which he is a member. Other Features: Pres. T. R. Davis appointed a nominating committee composed of H. V. Alexander, C. H. Hagedon and J. T. Hardin, and announced that the election will take place at the May meeting, with the new officers taking office in June. A picnic committee composed of W. H. Dwyer, Sr., and Riley Shuttleworth was also appointed. F. S. Boone submitted his report as treasurer. The membership was informed that the Year Book would go ahead as previously planned. I. W. Cotton, chairman of the membership committee, stated that a careful and sustained drive will be inaugurated to induce qualified persons to become members. Attendance 31.

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IOWA—March 11, 1947. Subject: Engineered Air Distribution. Speaker: V. M. Lathers, engineer, Barber-Colman Co., Rockford, Ill. In his speech, Mr. Lathers outlined the 14 points of air conditioning and some other pertinent factors to be taken into consideration in designing. He also stressed the problems which center around grilles, illustrating his contentions with slides, some of which showed the advantage of long narrow grilles and others outlining tests that are being made in grille designs. Other features: A limited amount of business was conducted due to an influenza epidemic which caused the absence of all the Chapter's officers. A report was given by C. H. McGuinness on the health situation in general. John Sandfort reported on the progress of the Iowa State Building Code and extended an invitation to members to attend the Midwest Power Conference. A motion, made to ask local senators to support a bill which would require the licensing of all engineers in heating plants in Iowa, was defeated. Attendance 28.

IOWA—February 11, 1947. Subject: Engineering, Past and Present. Speaker: Prof. E. M. Black, head, mechanical engineering department, Iowa State College, Ames, Ia. Though Professor Black spoke briefly about the history of engineering in general, his talk was mainly concerned with tracing the enrollment of engineering students in Iowa College, the type of engineering studied, and the courses necessary for an engineering degree. He stated that the current engineering curriculum includes more scientific courses, and that less emphasis is being placed on the practical application of this information. The members and their guests, many of whom were engineers from local industrial plants, found this subject of education very interesting and an open forum discussion was carried on for a considerable time after the meeting adjourned. Other Features: D. C. Murphy, treasurer, reported that a total of $103.00 had been contributed by members for the retirement of the Research Laboratory mortgage. Pres. E. O. Olson spoke on the activities in reference to the enactment of an Iowa state building code. Attendance 39.

IOWA—January 14, 1947. Social Meeting. Harry Frankel, president, Midwest Air Control Co., was host to his fellow members. An informal discussion was held on various subjects related to the industry, followed by an excellent dinner and entertainment. The minutes of the December meeting were read and approved. President Olson read a report on the contribution campaign for retirement of the mortgage on the Research Laboratory and contributions were accepted during the evening. The meeting being a social one, no other business was transacted. Attendance 32.

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KANSAS CITY—April 7, 1947. Subject: The Magic of Fire. Speaker: Harold F. Browne, U. S. Bureau of Mines, Dallas, Tex., assisted by C. M. Dovidas and M. V. Hansen, engineers, Bureau of Mines, Vincennes, Ind. This talk and demonstration dealt with fire and fire prevention as pertaining particularly to mineral products, especially gasoline, butane and other volatile fuels. Members and their guests, comprising the largest group to attend a Kansas City chapter meeting this year, found this talk highly in-

teresting and informative. Other Features: S. L. Furber, president, reported on the progress of the campaign to eliminate the mortgage on the Research Laboratory building in Cleveland. After H. A. Atwater gave a report on proposed legislation which would affect all professional men, a motion was carried to request the national headquarters to cooperate with any other group interested in changing the Wagner Act to exempt professional men. A report on a new smoke ordinance for Kansas City was endorsed by the Chapter. An invitation was received from the Southern California Chapter to attend the Semi-Annual meeting at Coronado, Calif. Attendance 106.

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MASSACHUSETTS—April 15, 1947. The election of the following officers for 1947-48 was announced: P. A. Croney, *president*; A. Ehrenzeller, *vice president*; R. T. Kern, *secretary-treasurer*. The officers with E. L. Blair, E. A. Dusossoit and R. R. Emerson constitute the *board of governors*. Chairmen of the various committees are: F. H. Brigham, membership; W. H. Shipp, papers and meetings; C. M. F. Peterson, social activities.

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MEMPHIS—March 17, 1947. Subject: Warm Air Heating. Speaker: Frank J. Nunlist, Jr., chief engineer, Mueller Furnace Co. A discussion followed Mr. Nunlist's interesting talk. Other Features: The nominating committee reported with two tickets, red and blue, for the election to be held April 21. Nominees on the red ticket were: N. C. Ledbetter, president; Walker Wellford, Jr., vice president; A. T. Bevil, secretary; Carl Fischer, treasurer; while the blue ticket consisted of Wano E. Thorpe, president; E. E. Scott, vice president; Alex T. Bevil, secretary, and Carl Wynn, treasurer. Communications were read and ordered filed. President Ledbetter asked that the membership be notified regarding the individual contributions to the retirement fund on the Research Laboratory building. Attendance 16. Attendance ratio 0.46.

MICHIGAN—April 21, 1947. Subject: Technology Tomorrow. Speaker: Dr. Baldwin M. Woods, president of ASHVE and director, University Extension, University of California. His excellent talk was thoroughly enjoyed by everyone attending and a rising vote of thanks was accorded him. Earlier in the evening Dr. Woods had explained to the chapter members the benefits to be obtained by the Society from the success of the voluntary drive to reduce the mortgage on the Research Laboratory building in Cleveland. Other Features: Reports were given on the state of the finances and on the Michigan chapter's plans for an annual meeting. Attendance 65.

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MINNESOTA—April 8, 1947. Subject: Refrigeration and Cooling. Speaker: R. C. Jordan, assistant head of department of mechanical engineering, University of Minnesota. In his talk, Professor Jordan covered the history of the development of mechanical methods of cooling. He presented his topic in an interesting manner, using slides to illustrate his subject. Other Features: The minutes of the March meeting were approved, and the Secretary also made an announcement concerning railroad reservations for the Society's Semi-Annual meeting in California. Mr. Lawrence reported on the favorable progress made toward eliminating the mortgage on the Research Laboratory. A report for the membership committee was given by Chairman B. F. McLouth, who reported that 63 new members had joined since last May. Details of the May meeting and annual party were also announced. Attendance 84.

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NEBRASKA—April 4, 1947. Subject: Electrical Appliances and the Heat Pump. Speaker: Fay Smith, operating manager, Omaha Public Power District. That the members and their guests found this topic very interesting was demonstrated by the questions and the lively discussion which followed Mr. Smith's talk. All regular business was suspended. Attendance 21.

NORTH CAROLINA—February 14, 1947. Subject: Practical Angles of Figuring and Installing Panel Heating. Speaker: Ferdinand Jehle, director of engineering, Hoffman Specialty Co., Indianapolis, Ind. A short speech was also given by P. B. Gordon, engineer and treasurer of Wolff & Munier, Inc., New York, N. Y., in which he discussed panel heating. Both gentlemen did an excellent job presenting their subjects and handling the discussion periods which followed. Other Features: Pres. C. Z. Adams, reporting on the Annual Meeting held in Cleveland, told of the desire of the Society to retire the Research Laboratory mortgage. A motion was carried setting a goal of $200.00 for the fund, with each member contributing $5.00. DeParx Stimson discussed the chapter's summer meeting and suggested that it be held the week end of June 13 at Roaring Gap. Attendance 117.

NORTH CAROLINA—December 13, 1946. Subject: The Application of Refrigeration to Textile Mill Air Conditioning. Speaker: P. L. Davidson, consulting engineer, Greeneville, S. C. After Mr. Davidson's stimulating speech, a lively discussion period followed. Other Features: A large proportion of those present being guests of the chapter, Pres. Adams introduced those who were from states other than North Carolina. E. S. deWitt and K. W. Selden, Jr. were thanked for the excellent work they had done in making the meeting a success. Program chairman, DeParx Stimson, reported on plans for the next three meetings. Attendance 110.

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NORTHERN OHIO—April 14, 1947. Subject: Adhesives and Coatings. Speaker: Fred Wehmer assisted by T. J. Levake, Minnesota Mining & Mfg. Co. Mr. Wehmer demonstrated several adhesives and coatings now being used for various purposes, such as corrosion prevention, metal to metal bonding, sound absorption and cementing of insulation. A discussion period followed this in-

teresting demonstration. Other Features: Judge Joseph P. Sullivan urged engineers to take an active part in important local civic projects now underway. Mr. Byers, reporting on progress to date on the city code, mentioned that much work still needed to be done. A report was given on the new plan for nominating national officers as adopted at the January meeting. The entertainment committee was instructed to make plans for a June golf party. Messrs. Taze, Gayman and Powers were elected to serve on the nominating committee to make recommendations for officers for the coming year. Attendance 65. Attendance ratio 0.41.

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NORTH TEXAS—April 18, 1947. Subject: Radiant Panel Heating Research Problems. Speaker: F. W. Hutchinson, professor of mechanical engineering, Purdue University, West Lafayette, Ind. Professor Hutchinson touched upon the research problems involved in maintaining a constant temperature control, location and method of installing heating panels and solar radiation as a means of heating. In conclusion, he stated that the research program on this type of heating was still in its infancy. Slides were used to illustrate the various points made. The members' interest in this subject was demonstrated in the lively discussion period which followed. Other Features: Reports were given on the status of the membership and on programs for future meetings. Attendance 54. Attendance ratio 0.68.

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ONTARIO—April 7, 1947. Subject: Inspection of Sunnybrook Military Hospital. Speakers: A. McGregor, A. F. Spencer, department of veterans' affairs, Sunnybrook Military Hospital, and H. H. Angus, consulting engineer. Mr. McGregor spoke on the reasons why Sunnybrook Military Hospital was built and for what purpose it was intended; Mr. Spencer discussed the general construction and engineering features of the hospital; and Mr. Angus, the details of mechanical equipment. Mr. W. H. Evans extended a vote of thanks on behalf of the chapter for a splendid meeting and a very enjoyable inspection tour. Other Features: D. O. Price submitted the following nominees for the coming year: D. A. Stott, president; E. G. Spall, vice president; H. R. Roth, secretary-treasurer; A. J. Strain, William Philip, J. H. Fox, V. J. Jenkinson, ex-officio, for board of governors. Attendance 86. Attendance ratio 0.40.

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PACIFIC NORTHWEST — April 8, 1947. Joint meeting with the Seattle chapter of the *ASRE*. Chairman Nickerson of the *ASRE* and Pres. R. E. LeRiche of the ASHVE opened the meeting and introduced the guests. M. C. McLennan, supervisor, heating and ventilating design, Puget Sound Navy Yard, Bremerton, Wash., spoke on Dehumidification of Inactivated Ships, in which he described the various dehumidification methods attempted both now and after the last war, the problems encountered and how they were to a large degree successfully solved. Also from the navy yard were: Mr. Markham, speaking on the various types of dehumidifying units now being utilized; and Mr. Sines, who described the methods of control used for the dehumidification units. A visit to inspect the dehumidification systems on the carrier Ticonderoga and the battleship Indiana, concluded the interesting and informative meeting. Attendance 67.

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PHILADELPHIA — April 10, 1947. Subject: Performance Characteristics of Axial Flow Fans. Speaker: D. D. Herrman, chief engineer, Hartzell Propeller Fan Co., Piqua, Ohio. An open discussion followed this interesting talk. Other Features: The treasurer's, and the auditing committee's reports were read and approved. Officers elected for the coming year include: E. H. Dafter, *president;* J. O. Kirkbride, *first vice president;* F. H. Buzzard, *second vice president;* J. W. McElgin, *treasurer;* L. A. Childs, *secretary;* E. A. Wagner, and other officers as *board of governors.* Attendance 80. Attendance Ratio 0.68.

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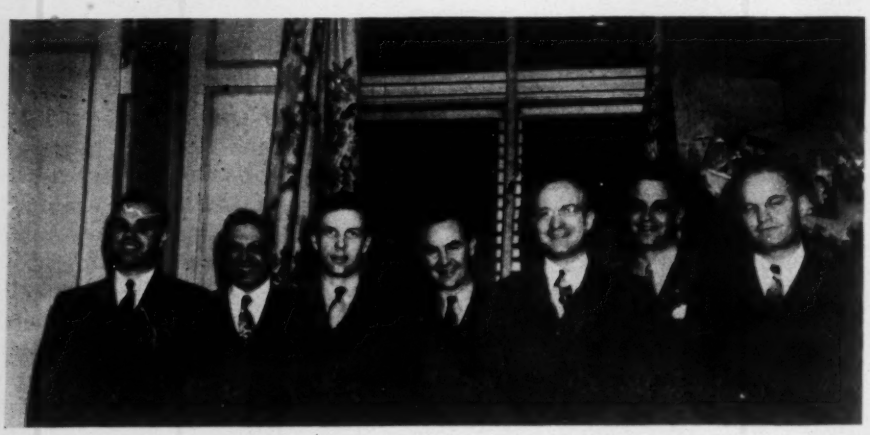
PITTSBURGH — April 11, 1947. Joint dinner meeting with *ASRE*. Mr. Scanlon, chairman of the meeting, introduced the officers of the ASHVE Pittsburgh chapter to their hosts, the *ASRE* membership. Subject: Future of Air Conditioning and Refrigeration. Speaker: G. G. Taubeneck, president and publisher, *Air Conditioning and Refrigerating News*, world-wide traveler and lecturer, and author of note. Before discussing his main topic Mr. Taubeneck spoke briefly about his new book, *One Foot in the Door*, dealing with the comic aspects and problems encountered in selling. A discussion period fol-

Oregon Chapter 1947-48 Officers

(l. to r.) **Pres. C. W. Brissenden, Vice Pres. E. R. Lokey, Sec'y. L. G. Williams, Treas. R. C. Chewning, Board of Governors, W. Bruce Morrison, W. R. Norte and W. J. Kollas**



lowed, during which many questions were asked concerning new air conditioning and refrigeration materials being produced. All regular business was dispensed with.

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PITTSBURGH — March 10, 1947. Subject: Decommissioning of Naval Ships. Speaker: E. R. Queer, professor of engineering research, Pennsylvania State College, State College, Pa. Professor Queer explained the process of preserving ships from deterioration by means of dehumidification and sealing the ship as a whole. He showed movies, which the Navy uses to train men in the application of the process, to illustrate his interesting talk. Other Features: John F. Collins, Jr., reporting for the nominating committee submitted the following as candidates: D. W. Loucks, president; H. E. Park, vice president; B. B. Reilly, treasurer; C. H. Schneider, E. C. Hach, and A. F. Nass for board of governors. A report on the chapter delegates' meetings in Cleveland was given by Mr. Loucks. Pres. Nass appointed Messrs. Collins, Moore and Edwards, to write up the history of the chapter. Attendance 42. Attendance ratio 0.48.

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ROCKY MOUNTAIN — April 2, 1947. Minutes of the previous meeting were read and approved, after which Pres. F. L. Adams asked for a report of committees. Mr. McEahern, chairman of the membership committee, announced new members. A report for the program committee was given by J. F. Mohan. Herman Woehlke, treasurer, submitted the final report for the fiscal year. Candidates for the year 1947-1948 were unanimously elected as follows: J. F. Mohan, *president;* B. A. Brickham, *vice president;* H. C. Kugeler, *secretary;* C. B. Hickey, *treasurer;* F. L. Trautman, F. C. Allen and Frank L. Adams, for *board of governors.* Retiring president Adams thanked the officers and members for their fine cooperation during the year. Attendance 19.

ST. LOUIS—March 4, 1947. Subject: Air Conditioning Systems for Multi-Story, Multi-Room Buildings. Speaker: C. L. Ringquist, manager, air conditioning department, The Trane Co., La Crosse, Wis. Mr. Ringquist described the survey and investigation of the potentialities of such systems made by his company, and of their final selection of a system which they would offer to the trade. He described in detail and illustrated with slides the development of recirculating type room units. Pres. B. C. Simons thanked the speaker for a very interesting lecture. Other Features: A motion was carried to have President Simons appoint a committee to arrange for the spring social party. A nominating committee to select candidates for 1947-48 officers was chosen. A letter from the Society for a Uniform Law Covering Pressure Vessels and Boilers was read and referred to the legislative committee. J. S. Rosebrough submitted a report on the treasury and W. J. Oonk reported for the membership committee. Attendance 44.

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SOUTHERN CALIFORNIA — March 12, 1947. Subject: The Trend in Theater Air Conditioning. Speaker: J. W. Banteau, chief engineer, Fox West Coast Theaters. Mr. Banteau traced the changes in air conditioning. He cited the problems which were encountered in different parts of the theater, pointing out that adequate exhaust is required in balconies where smoking is permitted. At the close of his interesting talk, he explained that the redesign of old theaters on the basis of new knowledge provided a very lucrative field for the air conditioning trade. Other Features: A report on chapter finances was submitted by J. L. Blake. J. S. Earhart reported on the fund for the mortgage on the Research Laboratory, and on the progress of a bill to register engineers in the state of California. Attendance 86.

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UTAH—April 10, 1947. Subject: Radiant Heating and Controls. Speaker: Ferdinand Jehle, director of heating, Hoffman Specialty Co., Indianapolis, Ind. Mr. Jehle covered in detail the steps followed in designing a typical panel heating system, emphasizing the use of graphs for the determination of mean radiant temperature, panel loading and coil spacing. Numerous questions were asked of Mr. Jehle by the members and guests, at the conclusion of his well presented talk. Other Features: Retiring president J. T. Young outlined the activities of the Utah chapter during the past year, after which he thanked his officers and committees for their fine cooperation, and turned the gavel over to president elect, Earl V. Gritton. On behalf of the chapter and as a token of appreciation, President Gritton presented Mr. Young with a Society emblem lapel pin set with a ruby. Attendance 44.

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WASHINGTON, D. C. — March 6, 1947. Dinner meeting held in conjunction with the *ASRE.* C. S. Stackpole acted as toastmaster. H. A. Magnuson gave a humorous version of the elements of heating and refrigeration, after which the main speaker of the evening G. W. Meek, consulting engineer, spoke on the subject, Principles of Air Conditioning and Refrigeration as Applied to Quick Freezing. Attendance 168.

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WESTERN NEW YORK—March 3, 1947. Joint meeting with the Ontario chapter. V. J. Jenkinson, president of the Ontario chapter presided. Various members of both chapters presented papers on Future Trends in Heating, after which the meeting was opened to general discussion. C. Lanze Rumble, manager, G. M. C. Canadian truck division, presented *Rumble's Rambles.* Highlight of the joint meeting was the dinner and entertainment arranged by the Ontario chapter. All regular business was dispensed with. Western New York Attendance 31. Total Attendance 120.

WESTERN NEW YORK—February 10, 1947. Subject: Personal Experi-

ences in Germany. Speaker: Richard D. Madison, research engineer, Buffalo Forge Co., Buffalo, N. Y. Mr. Madison, who was sent to Germany to observe and compile information on German fan design and manufacture after V-E day, gave a comprehensive talk on his personal experiences in that country. Other Features: Reports on the Cleveland meeting were submitted by President Seelbach, G. E. Adema and Ed Wilcox, who enlightened members on national delegate assignments, Research Laboratory mortgage reduction plan contributions and technical discussions which were conducted during the meetings. A brief talk on the purpose and plans of the Technical Societies Council and its coordination of some 21 local groups was given by Mr. Moselle. Attendance 52.

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WESTERN MICHIGAN—March 26, 1947. Subject: The Pitfalls of Partnerships. Speaker: William Wise, lawyer. In his speech Mr. Wise reached the conclusion that a firm should be incorporated to protect all the partners. A lengthy question period followed. Other Features: The chapter again was host to those attending the forced warm air short course at Michigan State College. A report in which they stated that many of the men attending these courses came from other states, one traveling a distance of 968 miles, was given by E. B. Root, Bruce McLouth, and C. H. Pesterfield. J. H. Van Alsburg gave an amusing portrayal of some of the things which happened in the South Pacific. Attendance 325.

WESTERN MICHIGAN — February 10, 1947. Subject: Reports on the Annual Meeting in Cleveland. T. D. Stafford gave an excellent description of the dedication of the new Research Laboratory. The various technical papers given at this meeting were discussed and a report was given on the panel heating forum held at Cleveland. A discussion involving panel heating followed, with John Wieland giving a very interesting report on controlling the panel heating systems. M. S. Sahab and J. A. Oberlin spoke on their impressions of the exhibits at the meeting. Other Features: After being informed that help from the ASHVE in modernizing the various codes in the City of Grand Rapids, would be appreciated, a motion was carried that the president appoint a committee, to work with the city on these codes. Mr. Van Alsburg asked that members seriously consider contributing more toward reducing the Research Laboratory mortgage.

WESTERN MICHIGAN — January 13, 1947. Subject: Public Relations Work with Pacific Island Natives. Speaker: Sam Street Hughes, former Mayor of Lansing, Mich. In his interesting talk Mr. Hughes expressed the opinion that our armed forces did a very good job of improving relations with natives on some of the islands in the Pacific. This was due, in most cases, to their democratic ways. Other Features: As this was Ladies' Night, all regular business was suspended. Attendance 82.

WASHINGTON, D. C., CHAPTERS OF ASHVE AND *ASRE* HOLD JOINT MEETING

A joint meeting of the ASHVE and the *ASRE* was held in Washington, D. C., March 6. The principal speaker of the evening, George W. Meek, consulting engineer and member of ASHVE, spoke before 170 members and guests of both Societies. Mr. Meek was assisted in presenting his subject, Principles of Air Conditioning and Refrigeration, by Van R. H. Greene, Jr., New York, N. Y.

Mr. Meek described the various systems and the techniques used in quick freezing. He pointed out that though the result was the same in all of the four general types, the choice of system was a matter of economics which must take into consideration maintenance, as well as first and operating costs.

Preceding Mr. Meek's talk, H. A. Magnuson gave a humorous version of the elements of heating and refrigeration.

Other prominent members of the ASHVE, Washington, D. C. Chapter present included: Paul R. Achenback, treasurer; L. Bert Nye, Jr., president; H. H. Hill, vice president, and W. H. Littleford, past president and member of board of governors.

Quick Freezing Described at Joint Meeting of ASHVE and *ASRE*

The Speakers' Table included Messrs. F. L. Grant, W. H. Littleford, A. S. Mitchell, H. H. Hill, W. H. Volker, Van R. H. Greene, G. W. Meek, (speaker) C. C. Stackpole, H. S. Hill, Alfred Chadburn, L. Bert Nye, Jr., M. C. Turpin, P. R. Achenback, W. S. Woodside, Dr. E. C. McCracken, and Herman Spoehrer

Candidates for Membership

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 87 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by June 25, 1947, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

ALGER, IRVING G., JR., Mech. Engr., G. M. Simonson. PROPOSERS: G. M. Simonson, N. A. Melnick. SECONDERS: P. R. Babcock, E. H. Goins.

ANDREW, GORDON J., Htg. & Indus. Engr., W. T. Andrew Co. PROPOSERS: W. H. Old, W. G. Boales. SECONDERS: G. W. Akers, H. H. Hughson.

ARMISTEAD, WILLIAM C., JR., Student, Vanderbilt University. PROPOSERS: Foskett Brown, W. C. Armistead. SECONDERS: W. F. Swats, E. C. Horn.

BALDWIN, KARL F., JR., Cons. Engr., Clyde E. Bentley. (*Advancement*) PROPOSERS: C. E. Bentley, H. V. Hickman. SECONDERS: D. F. Owens, N. H. Peterson.

BARTLETT, GEORGE M., Sales & Application Engr., Gulf Oil Corp. PROPOSERS: W. A. Johnson, H. C. Kelly. SECONDERS: E. C. Marsden, B. J. Wahlin.

BENNIS, RAYMOND R., Chief Engr., Contractors Refrigeration Corp. (*Advancement*) PROPOSERS: I. G. Jalonack, R. L. Stinard. SECONDERS: G. A. Belsky, M. B. Hulsapple*.

BERGER, JOHN V., Refrig. & Air Cond. Engr., McCombs Refrigeration Supply Co. PROPOSERS: J. H. McCabe, F. L. Adams. SECONDERS: G. D. Maves, J. J. Johnson.

BIGHAM, BRUCE H., Htg. Engr., Nelson Co. PROPOSERS: William Dixon, W. W. Jaffke. SECONDERS: F. R. Bishop, R. C. Champlin.

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Candidates Elected

In the past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by **Art. B-III**, *Section* 8, of the By-Laws, the following list of candidates elected:

Members

ARNDT, M. H., Chief, Mech. Stds. Div., National Housing Agency, Washington, D. C.

BECKER, PHILIP F., Elec. Engr., Board of Transportation, New York, N. Y.

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BUFFALANO, AUGUST C., Sales Engr., Johnson Service Co., New York, N. Y.

CROMIE, ROBERT W., Engr., Hajoca Corp., Lansdowne, Pa.

DURBIN, STEPHEN A., Dist. Mgr., Air Cond. Dept., General Electric Co., Kansas City, Mo.

FARRINGTON, WILLIAM R., Pres., The Farrington Co., Detroit, Mich.

FEDER, NATHAN, Vice-Pres., E. Kalisch, Inc., New York, N. Y. *(Advancement)*

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GOETHE, SAM P., Research Engr., University of Florida, Gainesville, Fla.

GRANT, ERIC C., Project Engr., Anemostat Corporation of America, New York, N. Y.

GRUITCH, JERRY M., Vice-Pres., The O. A. Sutton Corp., Wichita, Kans.

HARTMANN, HENRY, Cons. Engr., Brooklyn Union Gas Co., Brooklyn, N. Y.

HATZENBUEHLER, EDWIN J., Mgr., Indus. & Comm'l. Gas Dept., Lone Star Gas Co., Dallas, Tex.

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HUEBNER, WILLIAM O., Tech. Editor, Anemostat Corporation of America, New York, N. Y.

JENNINGS, HARVEY S., Dist. Mgr. & Sales Engr., Minneapolis-Honeywell Regulator Co., Spokane, Wash.

JENSEN, J. EBBE, Chief Engr., Western Blower Co., Seattle, Wash.

JOY, FRANK A., U. S. Navy, Bureau of Ships, Washington, D. C.

KANE, ARTHUR T., Cons. Engr., Seattle, Wash.

KEELER, FORREST J., Htg. & Vent. Supvsr., Los Angeles Board of Education, Los Angeles, Calif.

MARTIG, ROBERT W., Vice-Pres., Farnes & Martig, Inc., Portland, Ore.

MCNAMARA, GEORGE Q., Sales Engr. & Owner, George Q. McNamara, Inc., Detroit, Mich.

MEFFERT, GEORGE H., Chief Engr., Martin-Johnson Engineering Co., Dallas, Tex. *(Reinstatement & Advancement)*

MENEFEE, JESSE I., Arkansas Louisiana Gas Co., Shreveport, La. *(Reinstatement)*

MOWREY, CARL F., Dist. Repr., Air Cond. Dept., General Electric Co., Pittsburgh, Pa.

NELSON, CHARLES E., Sales Repr., Johnson Service Co., New York, N. Y.

ROBINSON, EDGAR R., Plant Constr. & Layout Engr., RCA Manufacturing Co., Inc., Camden, N. J. *(Advancement)*

SCHULER, WILLIAM R., Engr., Lasher & Fitzsimmons, Utica, N. Y.

SKINNER, NEIL D., Pres., Hoffman Specialty Co., Indianapolis, Ind.

SMITH, EDWARD O., Asst. Mgr., Inspection Dept., Eastern Gas & Fuel Associates, Pittsburgh, Pa.

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TAYLOR, DANIEL G., Chief Test Engr., Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

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RUPP, CHESTER J., Student, Michigan State College, East Lansing, Mich.
SCHIMPKE, BURTON J., Student, Michigan State College, East Lansing, Mich.
STEELE, HARRIS, Student, City College of New York, New York, N. Y.
WALMSLEY, ALBERT E., Student, University of Illinois, Champaign, Ill.

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Mr. Price joined the Society as a student in 1931, and was subsequently elected a Junior in 1934, and an Associate in 1937, becoming a member in 1939. He has had a varied, comprehensive experience as a representative and as a heating and air conditioning engineer.

Mr. Chester had been owner and manager of W. G. Chester and Son, representing various manufacturers, prior to his association with Mr. Price.

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Memphis: Organized, 1944. Headquarters, Memphis, Tenn. Meets, First Monday. President, N. C. Ledbetter, 22 S. Cooper St., Memphis 4. Secretary, A. T. Bevil, 1521 Waverly Ave., Memphis 6.

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Northern Ohio: Organized, 1916. Headquarters, Cleveland, Ohio. Meets, Second Monday. President, John James, 3170 W. 106th St., Cleveland 11. Secretary, W. M. Rowe, 1302 Swetland Bldg., Cleveland 15.

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Pacific Northwest: Organized, 1928. Headquarters, Seattle, Wash. Meets, Second Tuesday. President, R. E. Le Riche, 630 39th S. W., Seattle 6. Secretary, C. W. Finn, 320 8th Ave. N., Seattle 9.

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Rocky Mountain: Organized, 1944. Headquarters, Denver, Colo. Meets, First Wednesday. President, J. F. Mohan, 2229 Blake St., Denver 2. Secretary, H. C. Kugeler, 2365 Ash St., Denver 7.

•

St. Louis: Organized, 1918. Headquarters, St. Louis, Mo. Meets, First Tuesday. President, B. C. Simons, 4030 Chouteau, St. Louis 10. Secretary, W. A. Russell, 7918 Kingsbury Blvd., Clayton 5, Mo.

South Texas: Organized, 1938. Headquarters, Houston, Tex. Meets, Third Friday. President, B. P. Fisher, P. O. Box 32, Houston 1. Secretary, C. C. Quin, 809 Stuart Ave., Houston 6.

Southern California: Organized, 1930. Headquarters, Los Angeles, Calif. Meets, Second Wednesday. President, Art Theobald, 116½ S. King Rd. Secretary, R. S. Farr, 2615 Southwest Dr., Los Angeles 43.

Southwest Texas: Organized, 1946. Headquarters, San Antonio, Tex. President, F. C. Benham, Jr., 702 S. Flores St., San Antonio. Secretary, L. S. Pawkett, 810 Insurance Bldg., San Antonio 5, Tex.

•

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•

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Western Michigan: Organized, 1931. Headquarters, Grand Rapids, Mich. Meets, Second Monday. President, J. W. Miller, Route 5, Box 498, Lansing. Secretary, K. E. Robinson, 211 Smith Ave., Lansing 10.

Western New York: Organized, 1919. Headquarters, Buffalo, N. Y. Meets, Second Monday. President, G. E. Adema, 39 W. Balcom St., Buffalo 9. Secretary, J. H. Bryce, 88 E. Girard Blvd., Kenmore.

Wisconsin: Organized, 1922. Headquarters, Milwaukee, Wis. Meets, Third Monday. President, E. W. Gifford, 611 N. Broadway, Milwaukee 2. Secretary, B. M. Kluge, 1817 S. 66th St., Milwaukee 14.

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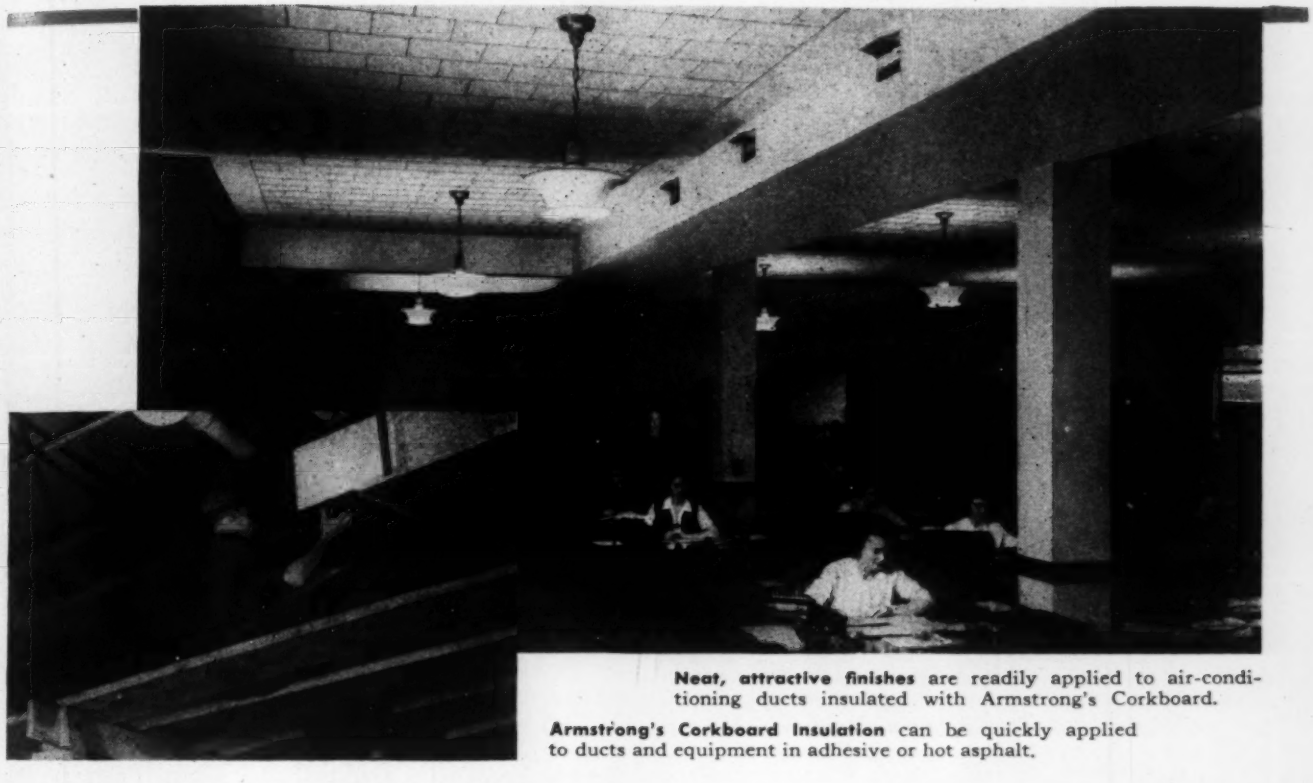
Texas A. & M. College: Organized, 1946. Headquarters, College Station, Tex. Meets, Third Thursday. President, G. H. Jackson, Texas A. & M. College, Box 2787. Secretary, T. V. Burns, Texas A. & M. College.

Armstrong's Corkboard Insulation Simplifies Duct Finishing



Neat, attractive finishes are readily applied to air-conditioning ducts insulated with Armstrong's Corkboard.

Armstrong's Corkboard Insulation can be quickly applied to ducts and equipment in adhesive or hot asphalt.

ATTRACTIVE finishes for exposed indoor air-conditioning ducts are practical when the insulation is Armstrong's Corkboard.

Primarily, this insulation is used to improve the operating efficiency of the system and to prevent condensation. But it is also a valuable aid to neat appearance. Since condensation does not occur on the surface of properly insulated air-conditioning ducts, there is no moisture to damage or discolor the finish.

For exposed ducts where appearance is an important factor, the corkboard insulation is covered with two layers of rosin-sized paper. Then 8-oz. canvas is applied with seams pasted or sewed. The canvas is sized and painted with lead and oil paint in the desired color.

Another widely specified finish for exposed ducts consists of two coats of asbestos cement applied over galvanized wire mesh which has been stapled and laced in place. This finish can be painted any color. It is also used—unpainted—over concealed corkboard insulated ducts when local building codes require finishing.

Where indoor ducts are exposed to unusual moisture conditions, the corkboard is given two coats of Armstrong's Asphalt Emulsion Finish to a total thickness of $\frac{1}{8}$" when dry. The finish can be painted with specially prepared aluminum paint or Armstrong's White Sealer-Enamel.

For details of these specifications, and engineering advice on any duct insulation or finishing problem, write to Armstrong Cork Company, Building Materials Division, 4406 Concord Street, Lancaster, Penna.

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Complete Contract Service For All Temperatures

From 300° Below Zero

To 2600° Fahrenheit

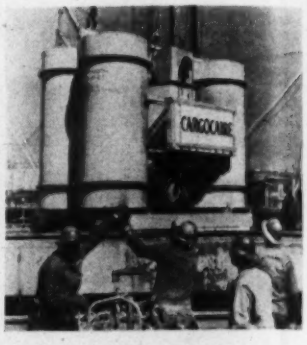
(*Continued from page* 171)

Solders Aluminum Without the Use of Acids or Flux

No. 3468—The "Super" aluminum solder offered by the Lenk Mfg. Co., Newton Lower Falls 62, Mass., is designed for soldering aluminum to any metal that can be soldered, without the use of acids or flux.**

Available in either wire or bar form, the solder is said to melt at approximately 450 F, thus providing a safety factor to prevent the distortion of parts to be soldered as aluminum melts at approximately 1215 F. According to the manufacturer, the tensile strength of butt joints is in excess of 10,000 psi.

Dehumidifier Redesigned to Save Weight, Space



No. 3469 — Cargocaire Engineering Corp., 15 Park Row, New York 7, N. Y., has announced a new dehumidifying unit for the preservation of ship cargoes. Called the "heart" of the company's shipboard dehumidification system, the new unit incorporates many new design features.

Among the outstanding advantages of the new unit, says the company, are a reduction of 50 per cent in weight, a 50 per cent reduction in required deck space, and a 6½ and 64 per cent reduction in steam consumption and electrical load, respectively. The unit is cycled automatically and is delivered aboard ship in packaged form.

Nonmetallic Disk Valve Designed for Liquefied Petroleum Service

No. 3470—Designed for high pressure liquefied petroleum service, the new "N-M-D" (nonmetallic disc) bronze valve has been developed by the Lunkenheimer Co., Waverly & Beekman Sts., Cincinnati 14, Ohio.

Made in globe, angle, and check patterns, sizes ¼ to 3 in., with screw ends, the valve is designed for 400 psi WOG service. The disc and stem packing are especially compounded for LPG service. A back seat above the stem threads is designed to permit repacking the valve under pressure when wide open.

The unit is recommended for use on liquefied petroleum gas systems, bulk transfer and storage tanks, domestic cylinder charging manifolds, vapor differential compressors, and general industrial uses.

Temperature Control System Used in Railroad Cars

No. 3471—"Rador," the war-developed heating control system, is now getting its first peace time application in railroad cars, according to the manufacturer, Vapor Car Heating Co., Inc., 80 E. Jackson Blvd., Chicago 4, Ill.

According to the company, the key of the system is a special control panel which automatically deter-

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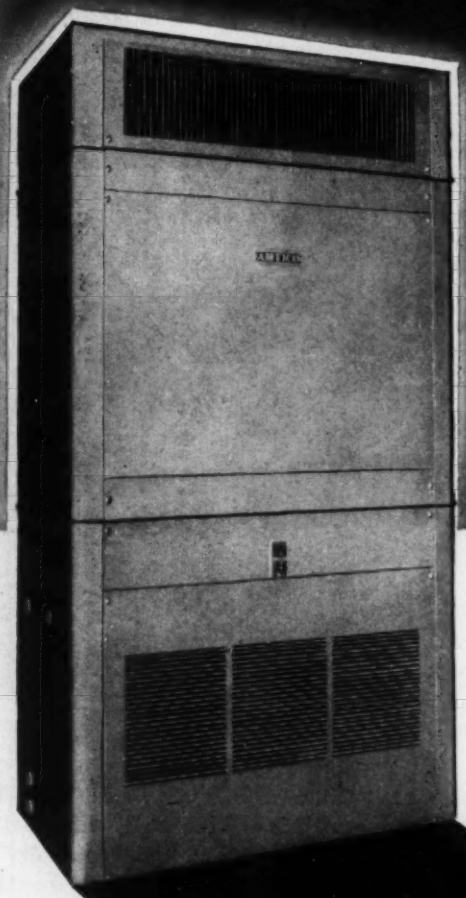

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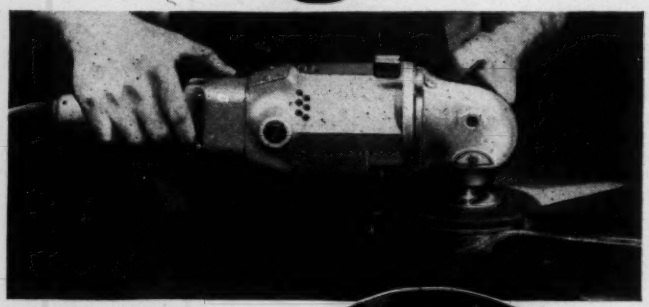

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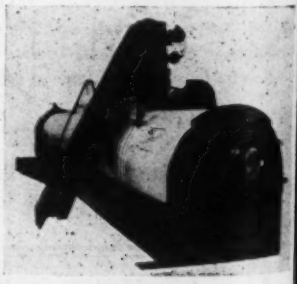
PORTABLE ELECTRIC TOOLS

mines whether heating, ventilating, or cooling is to be used in establishing the desired temperature. Each car is horizontally zoned to recognize such factors as train speed, car insulation, occupancy, sun load, etc. Vertical zoning is used to establish the relationship between overhead and floor heat. In operation, steam is "jetted" through the control valve of the heating unit in a cycle determined by the thermostats.

Heat distribution is achieved primarily through panel radiation located at the sides of the car. The heat rises through a duct at the side wall, with partial discharge at the window sill and the remainder of the heat passes out through the continuous duct making up the entire sidewall panel of the car. Approximately 20 to 25 per cent of the sidewall heat is used by the panel, the balance being discharged at the floor line. Principal parts of the system are indicated by numbers on the accompanying illustration as follows: (1) warm air outlets, (2) thermostats to control unit fin, (3) heat deflector, (4) unit fin radiation, (5) thermostat to control radiation in floor, and (6) radiation to warm the floor.

Oil-Fired Dehydrator Used for Farm Products



No. 3472—"The Challenger" is an oil-fired dehydrator which is designed to dry perishable farm feed products. It is fired by an industrial type rotary burner using heavy fuel oil manufactured by York-Shipley, Inc., York, Pa. The unit is manufactured by the J. B. Beaird Co., Inc., Shreveport, La.

The drying is done in a long, revolving cylindrical drum through which the furnace heat is drawn by an exhaust blower. The raw product is fed into a hopper

Simplifies Piping Installation With Arc Welding

By William P. Miller, Engineer
Smith & Oby Co., Heating Contractors, Cleveland, Ohio

IN the piping systems of the new 7-story addition to the Cleveland Clinic, we are using arc welding for pipe joints and for making brackets and hanger frames to simplify installation.

Fig. 1 shows the welding of risers which run about 120 feet from the basement to the top floor. At left and center are 5-inch feed and return pipes for air conditioning chilled water. At right is a 4" steam line. These horizontal welds in vertical pipe are made as shown in Fig. 2, using ⅛" "Fleetweld 5" Electrode for first pass and 3/16" for subsequent passes.

Fig. 2.

At each floor level the risers are held by the bracket frame shown in Fig. 3. It is made from 2" x 2" angle, corners formed by coping out one flange, bending and welding in one pass. Holding rings are cut from pipe and fillet welded to the frame. The frame is welded to the building structure as shown. Wedges hold the pipe until insulation is applied.

The basement support for these risers is shown in Fig. 4. The supports are made from the same diameter pipe, flame-cut to fit and welded in three

Fig. 1. Making finish pass on vertical pipe.

passes. A concrete column supports the three runs.

The frame—shown in Fig. 5—to hold copper water lines is made of ½" x 2½" bars, 28" and 6¾" in length. The ends are scarfed 45° and joined at corners with welds inside and outside. The plumbers' sleeves for different size pipes are cut from pipe and welded to the rectangle with continuous fillets. This frame fits over an opening in the concrete floor as shown.

We used "Fleetweld 5" electrode for all welding and a Lincoln "Shield-Arc

Fig. 4. Basement support for risers.

SAE" 300-amp. motor-driven welder, shown in Fig. 6.

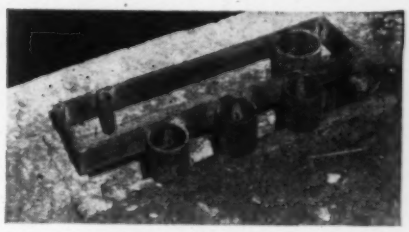


Fig. 5. Another frame for holding water lines at each floor level.

Specifications and procedures for "Fleetweld 5" and all other Lincoln electrodes are given in the Weldirectory. A free copy may be obtained by writing The Lincoln Electric Company, Dept. 472, Cleveland 1, Ohio.

Fig. 3. Bracket which holds risers in alignment is welded to I-beam joist.

Fig. 6. Adjusting controls of "Shield-Arc" motor-driven welder. Running gear is handy on construction jobs.

Advertisement

Boilers made in 6 sizes
up to 3040 sq. ft.
E. D. R. steam.

ALDRICH
HEAT-PAK OIL BURNERS
AND BURNER-BOILER UNITS

. . . because the name, ALDRICH, means quality! It is a reputation attained after years of manufacturing experience, engineering leadership, designing skill. For conclusive proof of performance and efficiency on the job, Aldrich HEAT-PAK products were standard equipment in U. S. Insular Bases. Aldrich, the leading oil burner manufacturer, *guarantees* satisfactory performance!

Because Aldrich will not sacrifice standards of quality, production will be slow until the shortage of good materials is overcome.

Model AX
.75 to 5.00 G.P.H.
Model BX
4.00 to 9.00 G.P.H.
Jumbo
5.00 to 19.00 G.P.H.

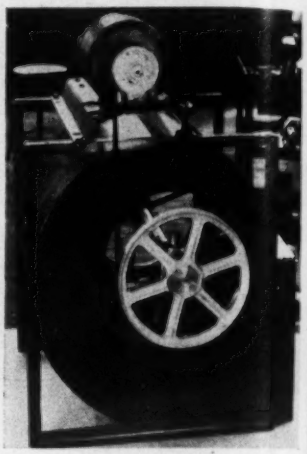
KNOWN and USED the WORLD AROUND!

ALDRICH COMPANY
WYOMING ILLINOIS

and is conveyed to the shredder, where revolving corrugated knives cut it up and feed it into the upper end of the dehydrator drum. The revolving drum feeds the drying products gradually to the separator, where they are ejected for cooling, sacking, and storage.

The unit is said to be suitable for dehydrating any type of livestock feed from beets to alfalfa.

Design Simplicity Features Blower

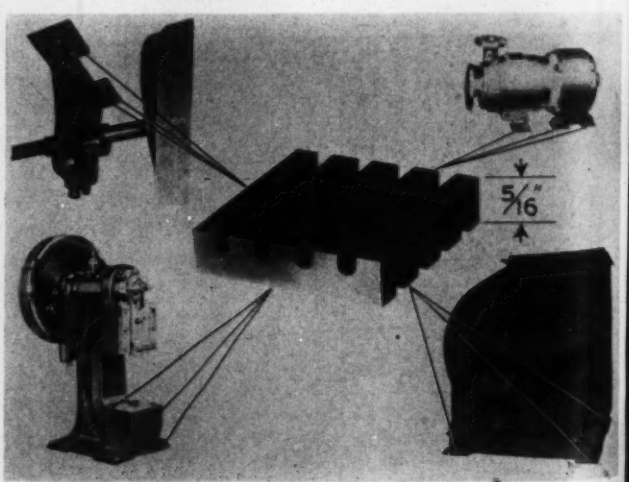


No. 3473—Type N universal blowers of the forward curve blade, centrifugal type have been developed by the Bishop & Babcock Mfg. Co., 4901-4915 Hamilton Ave., N. E., Cleveland 14, Ohio. Features of the blowers are said to include simplicity of design, convertible discharge, universal motor mount, and convertible rotation.

The blower can be changed with respect to discharge arrangement without moving the motor except for one discharge arrangement. The square mounting frame is used on sizes up to 16½ in. wheel diameter, and on the larger sizes the universal feature is attained by rotating the housing in its supporting frame. The motor mount is designed to fit all popular motor frames and is adaptable to any discharge. The convertible rotation is obtained only in double width blowers. Capacities of single blowers range up to 15,000 cfm at 1½ in. SP. Double blower units are also available.

Mounting Pads and Vibration Absorbers Have Many Uses

No. 3474—A new and inexpensive "Isomode" utility pad for use under all types of machinery as a mounting pad and vibration absorber has been announced by the MB Mfg. Co., Inc., New Haven 11, Conn.



The pads are made of neoprene and are designed to provide ruggedness, efficiency, and long life. They are said to be effective on all types and sizes of equipment

DON'T KEEP THESE SIX CULPRITS ON YOUR PAYROLL

FIRE THEM BY INSTALLING

CASH STANDARD *Streamlined* TYPE 1000 PRESSURE REDUCING VALVES

THERE are no jobs open for these cost makers in plants where the CASH STANDARD Streamlined Type 1000 Pressure Reducing Valve is installed. If such troubles as these six culprits represent are pestering you and costing good money while doing it, put an immediate and permanent stop to them. The STREAMLINER has a way of performing that definitely scratches these costmakers off your list. You then get all of the benefits that are listed directly below.

Bulletin "962" tells about the construction, the operation, and the effective performance of the Streamliner in plants like yours.

•

Maximum Capacity When Needed Most • Accurate Pressure Control Under Toughest Working Conditions • Trouble-Free Service • Smooth Operation • Tight Closure • Accurate Regulation • Speedier Production Results • Elimination of Failures • Constant Delivery Pressure • Cost Saving Operation • No Spoilage • Practically Zero in Maintenance Costs.

CASH STANDARD CONTROLS... VALVES

A. W. CASH COMPANY

DECATUR, ILLINOIS

•

BULLETINS AVAILABLE ON OTHER CASH STANDARD VALVES

Send for them

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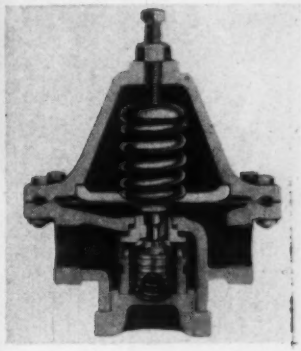
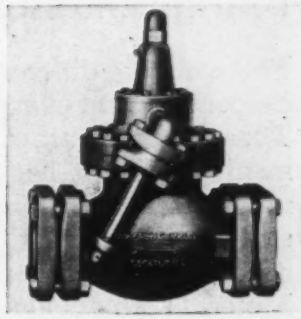
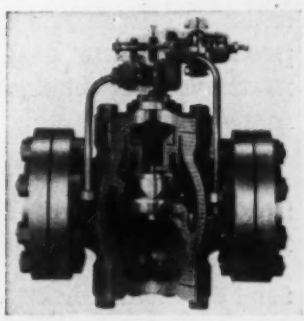


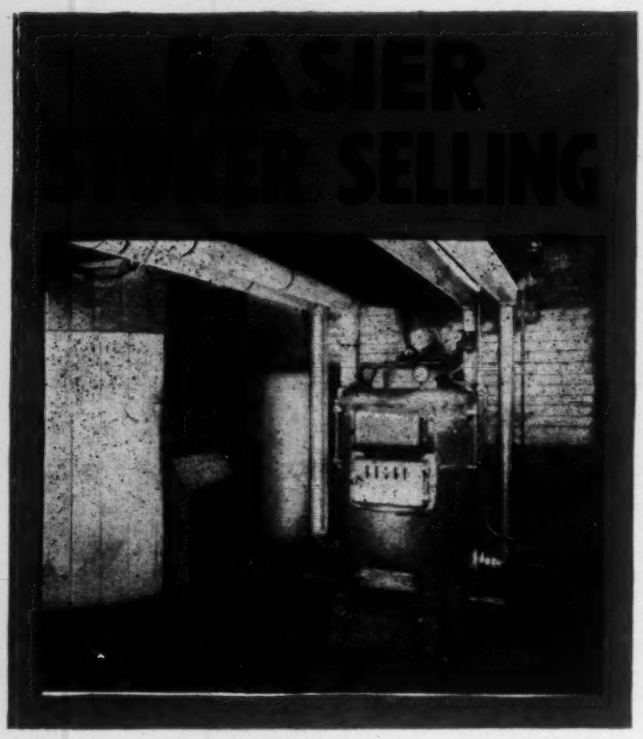
Bulletin 950—features the CASH STANDARD Type D Single Seat Pressure Reducing and Regulating Valves for use with most fluids. Shows simple inner working parts that save in maintenance. Diagram explains how valve works. Blueprint shows simplicity of installation.



Bulletin 956—features the CASH STANDARD Type 4030 Back Pressure Valve — designed to automatically maintain a constant pressure in the evaporator corresponding to a constant temperature desired. Shows an Ammonia and Freon Gas Capacity Chart based on ABSOLUTE pressures.



Bulletin 966—features the CASH STANDARD Self-Contained, Pilot Operated Type 10 Pressure Reducing and Regulating Valve for use with water or air; with any gas or oil that is non-corrosive; and with refrigerating fluids such as Ammonia and Freon. Many interesting particulars explained such as: how valve works, tight seating, large capacity, no waste, no water hammer or chatter.



—through planned promotion and mechanical superiority

There are big differences in the mechanical construction of automatic coal stokers. Through a program of laboratory development, Link-Belt has discarded for more modern features, things that other stokers still have. Link-Belt has for example, automatic air volume control, the Air Meter, (no manual setting after installation); sectional tuyeres; elimination of cleanout tube; automatic cutoff; elimination of deadplates on commercial models; and many other features.

This means easier selling and more satisfied customers; consequently greater profits per hour and per dollar invested in the stoker business. Let us tell you more about it.

LINK-BELT COMPANY, *Stoker Division*
2410 W. 18th St., Chicago 8, Illinois

Send data to _____

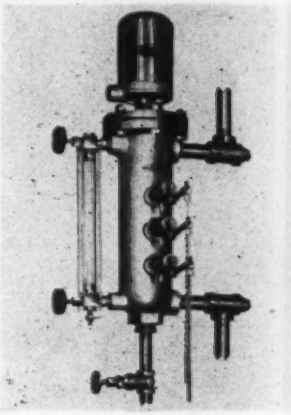
10,631

LINK-BELT Power-Flex Magic Flame STOKERS

from typewriters to forging hammers. Standard pads are 18 in. square, 5/16 in. thick, and can be cut to any desired size or shape.

According to the manufacturer, the pads are effective wherever there is a problem of noise, impact, or vibration. When used as a mounting pad or machine base they are said to reduce the time required for installation by eliminating the need for holding down bolts, skids, concrete mats, or grouting. Self-adjusting shims are used where uneven floors are encountered.

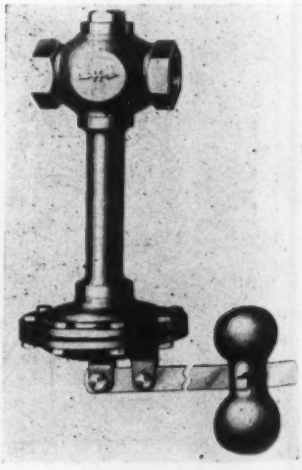
Combines Water Column and Water Level Control



No. 3475 — Magnetrol, Inc., Div. of Fred H. Schaub Engineering Co., Inc., 2110 S. Marshall Blvd., Chicago 23, Ill., has announced a new unit which combines both a water column and a multi-stage boiler water level control in a single unit. The device is available in two models, W-126 and W-251, for pressures up to 125 and 250 psi, respectively.

The combination unit is said to have all the features of the magnetic operating principle found in the company's standard multi-stage water level control and to offer numerous advantages, including lower first cost, ease of installation and space saving, unusual reliability because of the elimination of cross connection piping, and reduction in boiler maintenance because only one blowdown is required.

Reducing Valve Has Double Seat Design



No. 3476—The Series 700 low pressure reducing valves offered by Hoffman Specialty Co., 1001 York St., Indianapolis 7, Ind., are double seated in design and limited to continuous service applications, but are able to handle larger capacities than single seated reducing valves for equal pipe sizes. According to the manufacturer, simplicity of design makes the valves very sensitive and quick in response to changes in demands on the low pressure side.

The simple weight and lever, acting with diaphragm, is designed to provide quick and easy adjustment. Special fabric-inserted diaphragms are used on these all brass, semi-balanced units which are available in sizes from ½ to 1½ in. and which are designed for a maximum high pressure of 200 psi and a low pressure range from 1 to 25 psi.

WILLIAMS

SUPERIOR DROP-FORGED TOOLS

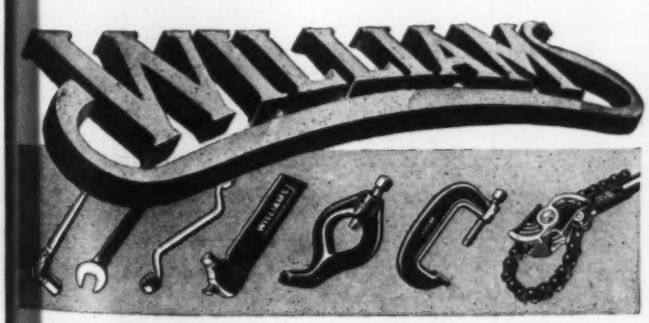
"VULCAN SUPERIOR" CHAIN PIPE VISES

Above: "VULCAN SUPERIOR", with reversible jaws and adjusting handle on top. 2 sizes for pipe 1/8 to 4-1/2 inches.

At right: "VULCAN". 4 sizes for pipe 1/8 to 8 inches.

● Williams "Vulcan Superior" is an improved vise featuring "over-head" adjustment handle ... making it easier and faster to use. Jaws are reversible providing double the service of conventional vises. It has larger capacity too. Each vise takes pipe 1/2" larger than other chain pipe vises of similar size. Like all Williams tools it is fully guaranteed. Sold by Industrial, Plumbing & Oil Field Distributors everywhere.

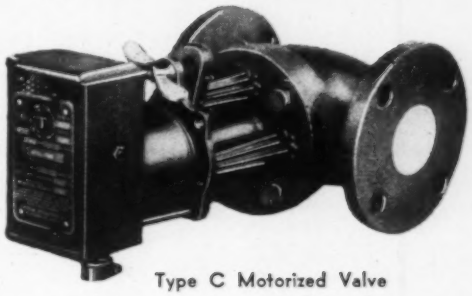
J. H. WILLIAMS & CO., BUFFALO 7, N. Y.



CUT COSTS

With—

TALLMADGE CONTROLS



Type C Motorized Valve

Tallmadge Controls offer these money-saving opportunities to the building industry:

(1) Heating Contractors, Engineers and Architects will find Tallmadge Controls are an important factor in figuring lower construction costs on their new projects this summer.

(2) Building Owners can take advantage of this summer's shut-down to modernize out-dated heating systems at reasonable costs, thus reducing fuel and operating expenses for many winters to come.

What Are Your Problems?

You are invited to ask Tallmadge engineers how they can lower equipment and operating costs for your buildings and new projects.

Wanted

FACTORY REPRESENTATIVES

To Contact ARCHITECTS, ENGINEERS, WHOLESALERS AND CONTRACTORS in Western, also Central, North and South Western States.

WEBSTER TALLMADGE & CO., INC.

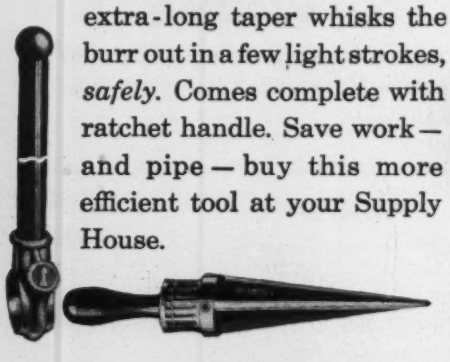
364 GLENWOOD AVE., EAST ORANGE, N. J.

Long-Tapered

FOR SAFE, QUICK PIPE REAMING

Extra-long-taper RIDGID takes work and risk out of pipe reaming

● No thinning of pipe or conduit, no flaring or splitting it, even when you ream it extra fast—as this RIDGID encourages you to do. That extra-long taper whisks the burr out in a few light strokes, *safely*. Comes complete with ratchet handle. Save work—and pipe—buy this more efficient tool at your Supply House.



Reamer unit sold alone for use in RIDGID No. 00R Ratchet Threader handle.

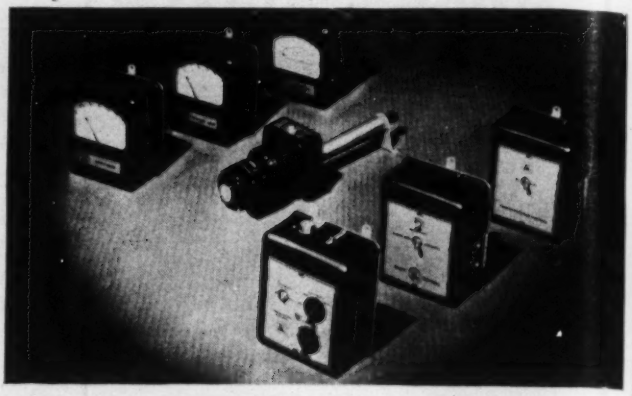
RIDGID

WORK-SAVER PIPE TOOLS

THE RIDGE TOOL COMPANY • ELYRIA, OHIO

Draft, Steam Pressure Operate Boiler Controls

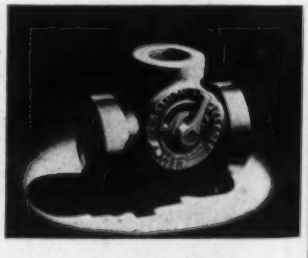
No. 3477—Seven new boiler controls and instruments, designed to operate on changes in steam pressure and furnace draft, are now in limited production by Perfex Corp., 500 W. Oklahoma Ave., Milwaukee 7, Wis.



The series 6080 actuator responds to remote control of draft or combustion controls to regulate dampers, lever valves, modulated stokers, and automatic oil burners. The series 7300 draft control operates the actuator in response to draft changes and is said to maintain any desired draft rate. The series 7200 damper program control is said to effect low "stand by" draft during off periods; opening the damper when starting and then returning to automatic operation with draft control. The series 7100 combustion control operates the actuator in response to steam pressure changes to control dampers, valves, and modulating equipment. Step timing is used to prevent over running and "hunting." The new draft gage, air pressure gage, and flue gas temperature indicator, also shown here, are designed to provide a visual check on boiler performance.

Offers Adjustable Tee for Hot Water Heating

No. 3478—An adjustable tee, now in production at the H. A. Thrush & Co., Peru, Ind., has been developed for use with one pipe, forced circulating hot water heating systems. It is installed in the single main to the supply branch of each upfeed radiator.

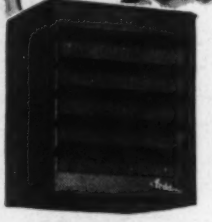


The diverter in this supply tee is adjustable by moving a small lever which may be locked in any position between fully open and closed. The unit is designed to regulate the flow of hot water to each radiator so as to control room temperatures. Increased flow through the main as the branch flow is reduced is said to be another important feature. When the branch is fully closed to a radiator, sufficient circulation will pass through the radiator to prevent freezing.

The unit is available in main sizes from 1 to 2 in. inclusive with various combinations of branch sizes from ½ to 1 in. The company's complete control system, using this adjustable tee, has been given the name, "Adustaflo" single main system of forced hot water heat.

THERE IS A FEDDERS UNIT HEATER MAN AS NEAR AS YOUR TELEPHONE

Heaters, Unit—
FEDDERS HEATING EQUIPMENT—
FEDDERS NEW YORK COMPANY
Unit Heaters—
415 Lexington Ave. . MUrray Hill 2-2002



Fedders Series 15 Unit Heaters are built in sizes from 100 to 1000 EDR

The men who represent Fedders are qualified to aid in selecting the proper size and type of Horizontal and Downblow Unit Heaters to fit every installation.

The classified section of telephone directories of principal cities carries the name of the Fedders representative under the heading HEATERS—UNIT.

Every Fedders representative sells by serving,—call him in on your work.

FEDDERS-QUIGAN CORPORATION
BUFFALO 7 • NEW YORK

Fast, efficient little RIDGID Nos. 00R and 111R for threading ⅛" to 1¼" pipe

● No slow complicated get-ready with these extra-handy small RIDGID threaders. You snap the die heads in easily from either side—can't fall out. You need no special dies for close-to-wall threads. Clean accurate threads always from heat-treated tool-steel dies. No. 00R, ⅛" to 1"—No. 111R, ⅛" to 1¼". Ask for these efficient durable threaders at your Supply House.

Handy free carrier for any group of sizes.

RIDGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL COMPANY • ELYRIA, OHIO

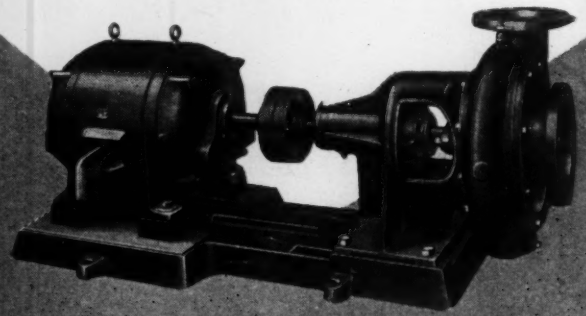
Designed by Specialists

WEINMAN PUMPS
For Cooling Systems

Weinman pump specialists have designed dependable pumps specifically for installation in cooling systems where quiet, efficient and leakless performance is most desirable.

The side-suction construction of Type GB and KB Centrifugal Pumps makes it easy to place the discharge opening in any one of four positions — even 8 positions at 45° intervals may be had if specifically ordered.

Write for Bulletin 727-B2.



Weinman Type KB Pump. Capacities to 1100 GPM, motor ratings of from 1 hp to 40 hp with 1750 or 3450 rpm.

Weinman pump specialists are always available to help you with any pump problem. Write, wire or 'phone — you will get immediate attention.

Built by Centrifugal Specialists
The WEINMAN Pump Mfg. Co.
COLUMBUS · 8 · OHIO

Equipment "Shorts"

Owing to the acute shortage of "Freon" refrigerants, Kinetic Chemicals, Inc., of Wilmington, Del., has discontinued its present practice of allowing credit on empty cylinders only to the national distributor or machine manufacturer who originally made a deposit. Under a new plan, designed to speed returns, credit or refund will be made to whoever returns the cylinders directly to the company. In addition to expediting the return of empty cylinders the new procedure is designed to simplify the handling of credits and refunds.

A new master kit of "Punch-Lok" bands for clamping or banding rubber hose to nipples and fittings and for a wide variety of general repair applications is now being merchandised by the B. F. Goodrich Co., Akron, Ohio.....From 90 to 97 per cent reduction in air-borne bacteria by the use of air filters is said to have been demonstrated in the laboratory of the Research Products Corp., Madison, Wis. In the experimental work a uniform dust mixture, obtained from the collector of a vacuum cleaner, was screened to obtain dust samples having different particle sizes. Test dust was then introduced into the air stream of a laboratory ventilation system. Samples of filtered and unfiltered air were drawn off and passed over Petrie dishes which contained a solution of agar of beef. Each dish was exposed to air samples for nine days in a sealed container, and at the end of this period bacteria colonies were counted.

The United States Safety Service Co. of Kansas City has been licensed to manufacture a small, portable carbon monoxide detector which was developed by the National Bureau of Standards during the war. The indicator is used for "the rapid determination of infinitesimal amounts of carbon monoxide in the air." The device is said to detect and to closely estimate concentrations of less than 0.002 ppm of air.

From a small local enterprise to a nationally known company with branches serving all sections of the country—this in brief is the history of the Charles Bruning Co., Inc. of Chicago, which this year is celebrating its 50th anniversary. The company is well known in the field of printing machines, sensitized paper, drafting and engineering equipment and materials.....A faucet gage for use in oil barrels, 30 or 55 gal, that does not have to be removed when putting oil into the barrel is now being manufactured by Bearlee Products Co., Green Bay, Wis.

Aluminum tubing for connecting gas appliances to house piping and for use on appliances and accessories is again being manufactured by the Reynolds Metals Co. of Louisville. The tubing, manufacture of which was discontinued during the war years, is approved by the American Gas Association for these services and is available in straight lengths and in coils.

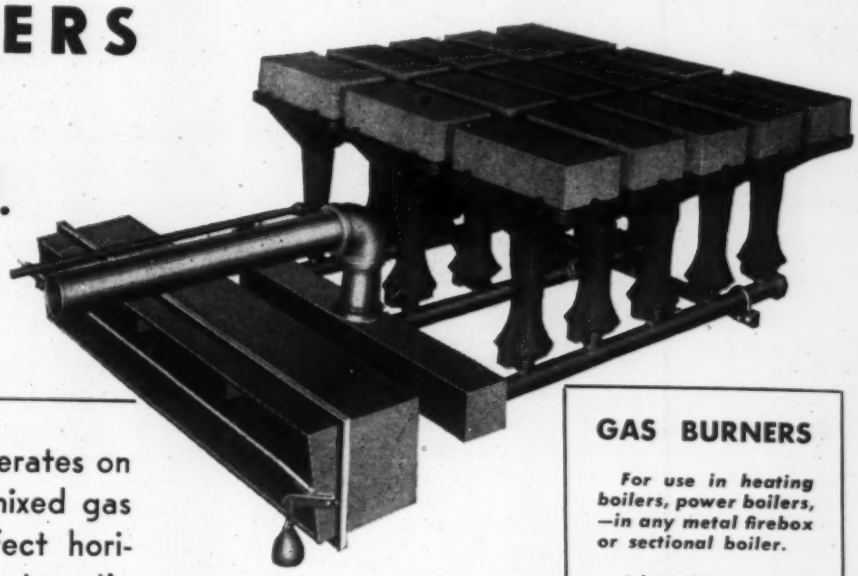
The "Cool-Ride" is a small, evaporative cooler designed for use on automobiles and trucks in hot, dry areas. The unit, offered by Alumina Steel Co. of Los Angeles, is composed of two parts. A one gallon pressurized tank (mounted under the hood, back seat, trunk, or under the dash) feeds water to a moisture eliminator and atomizing jet assembly located in the air entry of the cooler unit, mounted outside of the car on a window.

GAS BURNERS

Series F600

WECO—N.G.E.

50,000 to
10,000,000 B.t.u.



The Series F600 Burner operates on straight natural gas and mixed gas to 800 B.t.u. Gives perfect horizontal distribution. Fully automatic controls—that operate properly—can be easily applied.

Write for
F 600 Bulletin

GAS BURNERS

For use in heating boilers, power boilers, —in any metal firebox or sectional boiler.

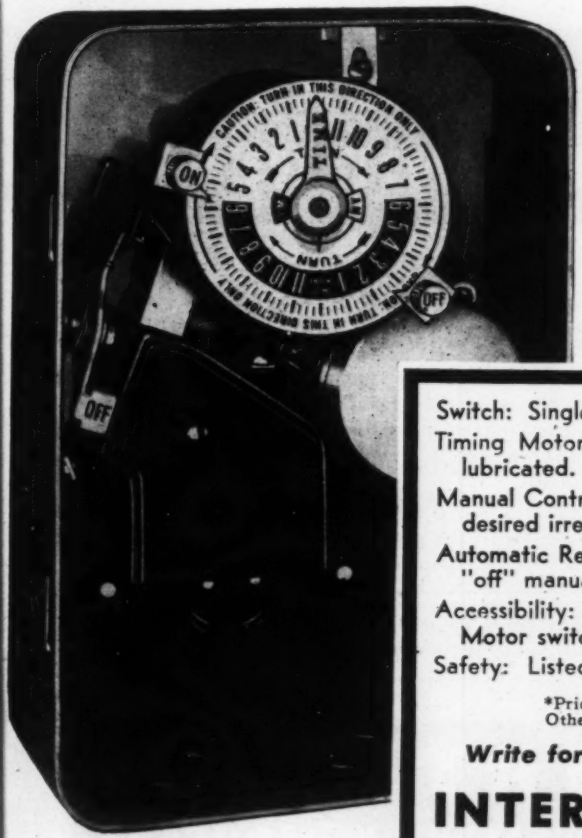
Adaptable to any firebox shape or size.

Handles various gas pressures and effects low draft loss.

THE WEBSTER ENGINEERING CO.

Surface Combustion Corp. — DIVISION OF — Toledo, Ohio

TULSA **OKLAHOMA**



"BIGGEST VALUE"

IN TIME SWITCHES

The *INTER-MATIC* **$9.00* LIST**

Switch: Single pole. 35 A. at 115 V.

Timing Motor: Synchronous. Self Starting. Fully enclosed. Permanently lubricated.

Manual Control: The switch may be turned "on" or "off" manually whenever desired irrespective of the time settings.

Automatic Reset: Regardless of whether the switch has been turned "on" or "off" manually, the time cycle is always resumed automatically.

Accessibility: Entire mechanism may be removed by loosening one screw. Motor switch, terminal block, etc., easily replaced.

Safety: Listed by Underwriters' Laboratory Re-examination Service.

*Price shown above is f.o.b. Chicago for 115 V. 60 cycle model. Other voltage and cycle combinations available at small extra charge.

Write for full information and names of nearest distributors

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NEW BOOKS & REPORTS

Describes Hydraulic Measurement Methods

The second edition of Hydraulic Measurements, by Herbert Addison, brings the descriptive material up to date but involves no major revision. The author, professor of hydraulics, Fuad I University, Giza, Egypt, has prepared primarily a reference book for engineers needing general information on methods of measurement, together with types of apparatus used. The text covers liquids only. While both European and American methods are discussed, the illustrations are largely of English equipment.

The book can roughly be divided into three sections. The first section deals with methods of measuring, indicating, recording, or transmitting fundamental quantities such as pressure head, weight, volume, and velocity. The next section covers methods of flow measurement in closed conduits. The last section deals with methods of flow in open channels and conduits.

This book is recommended to those who are interested in getting a general overall picture of the equipment and methods of hydraulic measurements. It is not particularly adapted to those who are interested in the specific design information, although the author includes a considerable amount of material which indicates the relative accuracy and limitations of the various methods which are available.

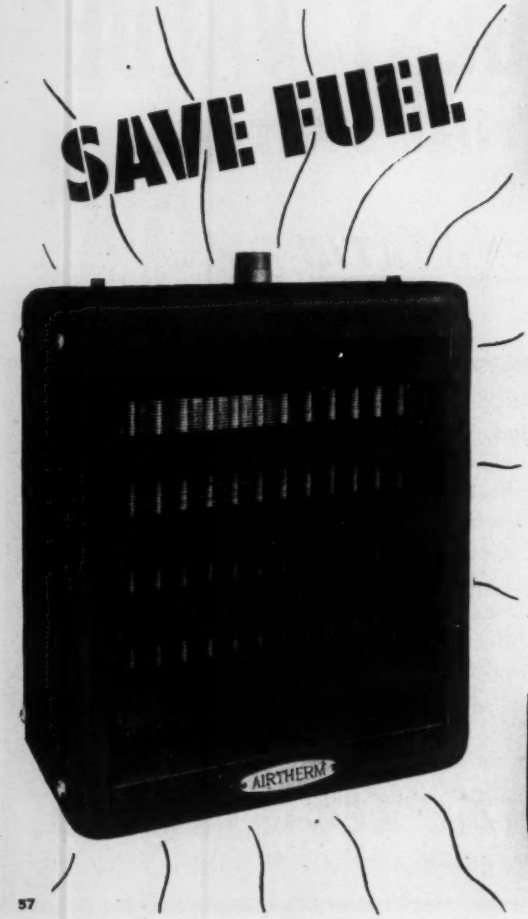
The text is published by John Wiley & Son, Inc., 440 Fourth Ave., New York City, contains 327+xii pp., and is priced at $5.00.—*Reviewed by E. N. Kemler, assistant director of research, research professor of mechanical engineering, New York University.*

New Standard Limits Concentrations of Trichloroethylene in Atmosphere

Although commonly used as a solvent in dry cleaning and as a degreaser in industry, trichloroethylene in sufficient concentrations has narcotic properties similar to chloroform. A sectional committee of the American Standards Association, under the chairmanship of W. P. Yant, director of research and development, Mine Safety Appliances Co., has concluded a study initiated in 1943 on the permissible concentrations of trichloroethylene in the atmosphere. The results of the study, together with recommended test procedures, are contained in a new standard published by the association.

It was found that prolonged or frequent exposure to the fumes at concentrations greater than 200 ppm in the air tend to cause nausea, dizziness, headache, and lethargy. In fact, the central nervous system and possibly the liver may be injured.

The study was sponsored by the American Industrial Hygiene Association and representatives of 17 other associations and government departments as well as 14 members at large interested in the problem. The new standard may be obtained from ASA headquarters at 70 E. 45th St., New York 17.



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PROVIDE HEAT WHERE YOU WANT IT—WHEN YOU WANT IT

Airtherm Steam Unit Heaters can be individually controlled, providing heat only when you need it, and where you want it—thus reflecting a saving in your fuel costs. They move warm air quickly over wide areas and into remote corners, giving uniform heat throughout the plant.

There's an Airtherm Steam Unit Heater for every heating application. Write for Bulletin 1206 giving detailed information and range of available sizes.

It's Wise to Buy From Your Distributor . . . He carries complete stocks to supply your requirements—when needed—as needed.

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57

BEND COLD PIPE QUICKLY, EASILY

Speed piping installations this efficient, easy, economical way . . . make "on the job" bends in pipe up to 4½" with a GREENLEE Hydraulic Bender.

With a GREENLEE *one man* makes smooth, accurate, uniform bends in a few minutes. You save greatly through elimination of manufactured bends, many fittings, and the work of threading them. And, in timesavings alone, the GREENLEE pays for itself quickly.

Simple to operate, easy to carry, set up, and shift from job to job . . . lets you bend pipe exactly where and when you want it. Ideal for radiant heating jobs. For complete details write for free folder S-121. Greenlee Tool Co., Division of Greenlee Bros. & Co., 2346 Twelfth Street, Rockford, Illinois.

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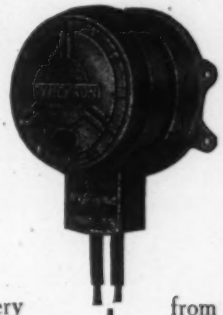
FOR THE CRAFTSMAN

If you make timing machines, time recorders, time switches or any other type of timing device—you should get the facts about SYNCHRON Synchronous self-starting motors—

These tiny SYNCHRON motors are compactly built, with rotor and coil nested in a sturdy, streamlined case 2¾" x 1-5/16" —with power to pull 8 oz. direct load continuously at 1 RPM.



Complete customer satisfaction is assured by precision construction in every detail: including specially hardened steel shafts, polished brass gears, with oil-impregnated double bearings, and positive life-time lubrication. Pre-tested, to operate at 40 degrees below zero or 140 degrees above.

Standard SYNCHRON Motors are available in speeds from 1 to 300 RPM, clockwise or counter-clockwise, in all voltages and cycles. And other speeds can be furnished to meet special requirements. Write HANSEN MFG. CO., INC. at Princeton, Indiana for catalog and prices.

SYNCHRON
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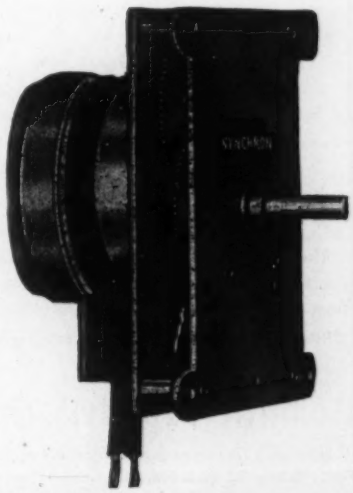

*The tiny SYNCHRON Motor gives power and stamina to SYNCHRON Timing Machines. Self-starting, syncronous, self-lubricating, quiet, long-wearing. Operates at standard intervals of 1 RPM, 1 RPH, 1 RP12H, and 1 RPD. Other intervals if desired.

Self-Cleaning Feature of

DEPENDABLE

Water Regulating Valve

. . . MEANS "TROUBLE-FREE" ACCURACY AND LONGER SERVICE

You'll avoid trouble—

due to dirt and lime in your water when you install the new A-P Model 68-B Water Regulating Valve on your water-cooled condensing units. A radically different construction principle actually "cleans itself," employing a molded composition seal on the valve stem which moves across the polished mirror-smooth stainless steel seat with an effective "wiping" action. Laboratory tested in sandy water, this unique sliding seal and seat showed no sign of water after the equivalent of many years use — proof of "lifetime" of accurate water regulating service.

With an operating head pressure of 50 to 150 p.s.i. Model 68-B can be easily adjusted to your system through the wide port in the body. Its long stroke provides closer, more uniform control without chattering or water-hammer. Three sizes, 3/8", 1/2" and 3/4" inlet and outlet, offer a wide range of utility on Freon, Methyl Chloride or Sulphur Dioxide systems. Buy it today at your leading Refrigeration Jobbers — or write for bulletin No. M100.

DEPENDABLE Refrigeration Valves include: Thermostatic Expansion Valves, Refrigerant and Water Solenoids, Suction Pressure Regulating Valves, "Trap-Dri" Drier-Filter-Strainer and "Trap-It" Filter-Strainer, and Thermostats for cooling or heating.

AUTOMATIC PRODUCTS COMPANY

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DEPENDABLE REFRIGERANT VALVES

FOR AIR CONDITIONING • REFRIGERATION • HEATING

MEETINGS & CONVENTIONS

Aircraft Conditioning, Bolting, Heat Pump Among ASME Papers

Opening at the Chicago headquarters hotel, the Stevens, on Sunday, June 15, the semi-annual meeting of the American Society of Mechanical Engineers, 29 W. 39th St., New York City, will continue through June 19 with some 40 technical sessions, inspection trips, and entertainment features scheduled. Total registration is expected to exceed 3000.

The many technical papers, which are scheduled for presentation, will include one on aircraft cabin supercharging and air conditioning by engine bleedoff, by R. B. Keusch (to be given at 2:30 p. m., June 16). The morning sessions of June 17 will include papers on cast bolts for pipe joints, by C. K. Donoho and a review of some heat pump installations, by E. B. Penrod. Professor E. N. Kemler, New York University will present a paper during the power session. At 8:15 p. m., June 17, B. R. Prentice will discuss atomic power engineering and at the fuels general luncheon to be held on Wednesday, H. J. Rose will talk on trends in solid fuel research.

ASTM Meeting to Have Many Technical Sessions

At the 50th annual meeting of the American Society for Testing Materials, to be held at the Chalfonte and Haddon Hall hotels, Atlantic City, the week of June 16 there will be 19 sessions devoted to the presentation of more than 100 technical papers and committee reports. Insulating oils, electrodeposited coatings, synthetic lubricants, plastic deformation of metals, rubber testing, water-formed deposits, fatigue, and plastics are some of the topics to be discussed in the various sessions.

Association headquarters is at 1916 Race St., Philadelphia 3, Pa.

Stoker Manufacturers to Meet Near Chattanooga

The 1947 annual meeting of the Stoker Manufacturers Association, 307 N. Michigan Ave., Chicago, will be held at Lookout Mountain, Tenn. (near Chattanooga), June 16 to 18.

Technical Papers to Feature NDHA 38th Annual Meeting

Members of the National District Heating Association will meet at Atlantic City, June 24 to 27 for the 38th annual meeting which will be held at the Chalfonte and Haddon Hall hotels. The technical papers, which are scheduled for presentation during various committee reports, will include discussions of temperature control, the use of steam for air conditioning in New York City, various aspects of steam flow metering, packing for slip type expansion joints, and the protection of boilers which are not in service.

Association headquarters is at 827 N. Euclid Ave., Pittsburgh 6, Pa., and J. F. Collins, Jr., is secretary.

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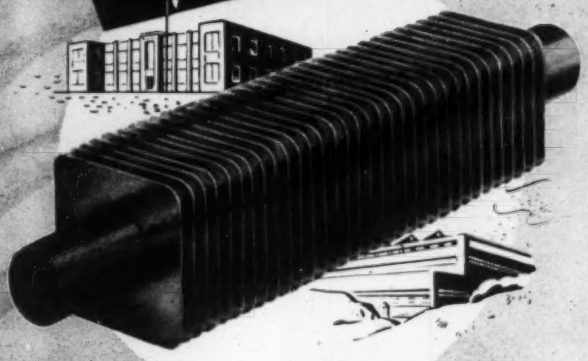

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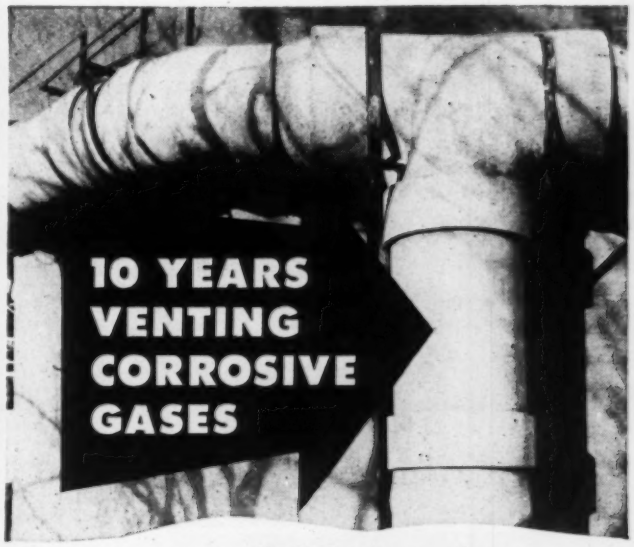

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has never required maintenance

TEN YEARS AGO, the operators of the Dunellen, Plainfield and North Plainfield (N. J.) joint sewage disposal plant faced a serious maintenance problem. Every eight months, the duct carrying corrosive gases from the sludge-drying chambers had to be replaced. Then this plant installed Transite Duct . . . and in 10 years not one cent has been spent for maintenance.

Strong and durable, Transite Industrial Vent Pipe successfully resists many of the corrosive gases, vapors and fumes met in industrial operations . . . provides effective, economical venting service in many industries.

You can use this asbestos-cement pipe outdoors or indoors, for it is rustproof and weather-resistant . . . needs no painting. Light in weight and readily assembled, it comes in 19 sizes from 2" to 36" in diameter . . . with a full line of Transite fittings to assure corrosion-resistance throughout the system.

Data Sheet DS-336 gives full details and is free on request. Address Johns-Manville, Box 290, New York 16, New York.

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Automobile	Furnace	Railroad
Baking	Furniture	Rayon
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Boiler Works	Glass	Rubber
Brewing	Laboratory	Shipbuilding
Canning	Laundry	Sewage Works
Ceramic	Leather	Shoe
Chemical	Meat Packing	Smelting
Dairy	Metal	Soap
Drug	Mining	Soft Drink
Electrical	Paint	Sugar Refining
Explosive	Petroleum	Textile
Farm Machinery	Potash	Tool
Food	Pulp & Paper	Water Work.

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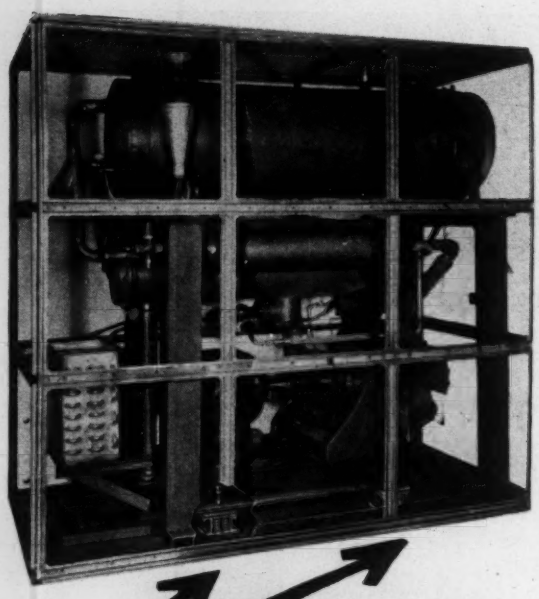
TRANSITE Industrial Vent PIPE



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UNCONTROLLED vibration in compressors, condensers, fans and unit conditioners, can prevent one of the main benefits of air conditioning—silent, unnoticeable operation.

And this silent operation can be obtained so easily! Standard Korfund-Engineered Vibration Control Units include the specially-developed Twin Rail Fan Base and Vibro-Isolators. Korfund utilizes steel-spring, rubber or cork materials to give the exact amount of isolation required.

Over forty-five years of experience in designing vibration control equipment enables Korfund to supply the answer to your vibration problem—and it's both economical and efficient. Write today for more details.

KORFUND VIBRATION CONTROL

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IF YOUR BOILER CONTROL IS A *MAGNETROL* YOUR WATER LEVEL IS *SAFE!*

MAGNETROL provides today's most dependable method of pump control, low water fuel cut-off and low water alarm. *It's simple, positive, foolproof!* That's because changes in water level are transmitted to the switching mechanism by magnetic action. *There are no bellows . . . no stuffing box . . . no diaphragms . . . no electrodes!*

Float-actuated piston has no mechanical or electrical contact with switch. MAGNETROL'S highly dependable performance is proved by use in every type of plant *under all conditions.* MAGNETROL is the guiding hand on every Schaub Boiler Return System . . . *and can be used with any electric boiler feed pump for greater reliability.*

NEW "UNITARY" SWITCHING MECHANISM

Quick changes in Magnetrol's operating functions are possible with the new "Unitary" switching mechanism. Completely self-contained, it is installed or replaced on the job as simply as changing cells in a flashlight. Switch spacing and level differential are easily adjusted. *No special tools or skill are required.*

MAGNETROL STANDARD MULTI-STAGE CONTROLS

Model 251 (illustrated above) for pressures up to 250 lbs. . . . Model 126 for pressures up to 125 lbs. Normally, these provide 2-stage control. Upper stage starts and stops boiler feed pump. Lower stage controls low water fuel cut-off or alarm—or both. A third level stage can be added, if desired, for two-stage pump control.

MAGNETROL COMBINATION WATER COLUMN & CONTROL

Models W-126 and W-251 for pressures of 125 and 250 lbs. respectively. A longer float chamber has tapped outlets for gauge glass and three try-cocks, and conforms to ASME Code water column design. These models therefore combine the functions of both water column and controller.

MAGNETROL SINGLE-STAGE CONTROL

Model 249 (pressures up to 250 lbs.). Ideal for low water cut-off and/or alarm function only.

Write for Bulletin 147 and full information on Magnetrol Boiler Water Level Controls.

MAGNETROL, Inc.
A Division of Fred H. Schaub Engineering Co. Inc.
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To Hold Smoke Prevention Meeting in Toronto

The 40th annual meeting of the Smoke Prevention Association of America will be held July 7 to 10 in Toronto, Canada, with headquarters at the Royal York hotel. According to a recent announcement, it will be necessary for those attending to make early reservations, and in order to secure accommodations, the reservations should be made through the office of the secretary, F. A. Chambers, 139 N. Clark St., Chicago 2, Ill.

Industrial Hydraulics Conference to be Held in Chicago

The third annual meeting of the National Conference on Industrial Hydraulics (formerly the Hydraulic Machinery Conference) will be held, October 16 and 17, at the Hotel Continental in Chicago. The conference is sponsored by Armour Research Foundation and the graduate school of Illinois Institute of Technology in cooperation with the Chicago sections of the SAE, ASCE, and ASME.

The subjects of the four half day sessions will include cavitation, industrial application of hydraulics, and hydraulic controls. Additional information may be obtained from Dr. V. L. Streeter, Armour Research Foundation, Technology Center, Chicago 16, Ill.

AWS Members to Meet During Metal Congress

The American Welding Society, 33 W. 39th St., New York City, will hold its 1947 annual meeting, October 19-24, at the Sherman hotel, Chicago. As usual, the meeting will convene during the National Metal Congress and Exposition.

M. M. Kelly, society secretary, stresses the importance of early reservations because of the large attendance expected at the simultaneous meetings.

West Coast Chemical Show Planned for October

An industrial chemical conference and display for the western states and Pacific area are scheduled for the Civic Auditorium in San Francisco, Oct. 21-25. This is the first regularly scheduled Pacific Chemical Exposition and will be presented by the California section of the American Chemical Society, whose headquarters is at the Whitcomb hotel, San Francisco.

Atlantic City Choice of ASME for 68th Annual Meeting

The 1947 annual meeting of The American Society of Mechanical Engineers, 29 W. 39th St., New York City, will be held at the Chalfonte and Haddon Hall hotels, Atlantic City, December 1-5. This will be only the third time in the society's history that it has held the largest of its national gatherings outside of New York City.

1948 AGA Convention to Be Held in Atlantic City

The 1948 convention of the American Gas Association, 420 Lexington Ave., New York City, will be held in Atlantic City the week of October 4.

YOU CAN GET IT QUICKER FROM

STEWART

QUICK FACTS ABOUT HIGH VELOCITY OUTLETS MADE BY STEWART

The styles illustrated are typical examples of improvements in the Stewart line of Outlets, Wall and Baseboard Registers, Scoopaires and Radiator Fronts. All have been redesigned for smarter appearance, better diffusion and more flexible adjustment. The Stewart line is competitively priced and includes a wide range of popular types and sizes of outlets for air-conditioning, heating and ventilating. Special types and sizes can be made to your specifications.

PROMPT DELIVERIES ON STANDARD SIZES

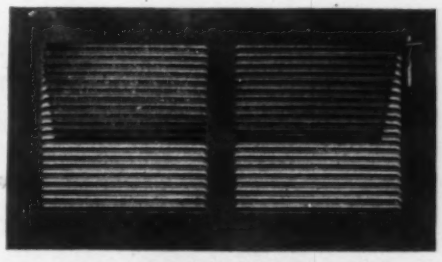
STYLE DDV

(2 Banks) Individually Adjustable Face and Rear Bars

Style DDV is one of 8 variations of Stewart High Velocity Outlets. By means of a detachable key, all bars are adjustable for directing air straight and at various right-left or up-down angles. Style DDV has vertical face bars and horizontal rear bars. Style DDH (not shown) has horizontal face bars and vertical rear bars. This type of outlet is made in popular sizes with or without lever-operated, multiple volume valves. Matching intakes are available. OUTLETS CAN BE SUPPLIED TO FIT CONTOURS OF CABINETS FOR ROOM COOLERS.

STYLE 91

Lever-operated Single Damper Wall Register



STYLE 91 is from the series 70-90 of Wall and Baseboard Registers made with single dampers, or multiple-valve dampers, both lever operated. Face bars of the 90 series are horizontal and set down at a 22 degrees angle. Face bars of the 70 series are vertical, set straight. Setting keys are furnished for user to alter bar settings. Matching, fixed bar grilles are available.

Send for literature and prompt quotation on your requirements

STEWART MANUFACTURING COMPANY
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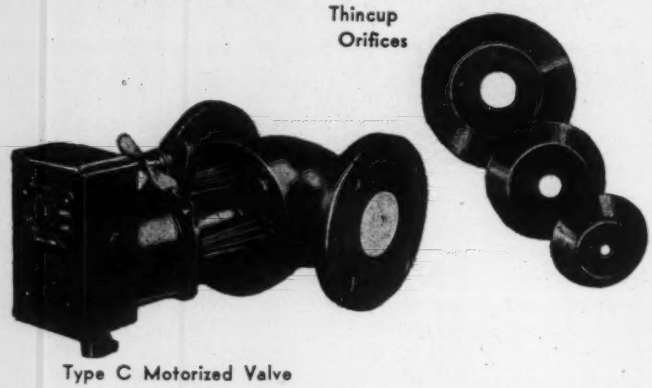
TALLMADGE

ON-OFF HEATING CONTROLS

Combine Simplicity and Low Cost



Type C Motorized Valve

Tallmadge On-Off Heating Controls are available in a variety of combinations that meet most heating requirements for thermostat regulation. Their advantages are widely recognized by leading engineers, heating contractors and building owners.

The controls for each zone include a rugged type "C" Motorized Valve regulated by a positive-action thermostat. The type "C" Valve shown, can, at any time, readily be converted to a modulating type valve. Thincup Orifices for insertion in radiator inlets are also provided to maintain even distribution of steam to all parts of the heating system.

Tallmadge Controls are backed by 18 years' experience in meeting all steam heating requirements in institutional, commercial and industrial buildings.

Complete detail information will be supplied on receipt of an inquiry indicating your general requirements whether for On-Off or Modulating types of heating systems.

FOR IMMEDIATE DELIVERY

(1) Motorized Valves

(2) Vacuum Breakers

(3) Thincup Orifices

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RECENT TRADE LITERATURE

For your convenience in obtaining copies of these bulletins, see coupon on page 171. If you write direct to the manufacturer, describe carefully what literature you want, as the number given first in each item is for use only when sending requests to Heating, Piping & Air Conditioning.

Acetylene Generators and Manifolds

No. 6526—Air Reduction Sales Co., 60 E. 42nd St., New York 17, N. Y., has announced a 22 page catalog which lists and explains the company's line of "Airco" acetylene generators and manifolds for both oxygen and acetylene. Stationary generators covered are the 300 lb (both single and double rated) and the 500 lb double rated. The portable generators range in size from 15 to 50 lb. The manifolds, which are described, include both simplex and duplex types for use with oxygen, stationary types for use with acetylene, and portable types for both gases. Also included are various types of manifolds for other gases such as carbon dioxide and hydrogen.

Air Distribution and Duct Design

No. 6527—A brief history of theater air conditioning with emphasis on the use of the company's air diffusers is featured in the Vol. 3, No. 2 issue of Aspiration, the house organ of the Anemostat Corporation of America, 10 E. 39th St., New York 16, N. Y. Some of the fundamentals of duct design are briefly reviewed in the first in a series of short articles on this subject.

Color of Paints and Heat Absorption

No. 6528—Data on the relative effects of paint colors in regard to heat absorption is contained in the Vol. 39, No. 1 issue of the Dutch Boy Painter, the house organ of the National Lead Co., 111 Broadway, New York 6, N. Y. A brief article cites test results as reported by the U. S. Bureau of Mines and the National Bureau of Standards. Test results indicate that white paints provide the coolest surfaces.

Damper and Frame

No. 6529—A sheet metal damper and frame with brass fittings, which is designed to operate as a complete unit in vent flues on unit ventilated buildings, vent stacks, and ventilators, is described and illustrated in a four page folder issued by the Springfield Ventilating Works, 137 Armory St., Springfield, Mass. The damper and frame are rectangular and the damper is suspended from diagonal corners. This is said to permit bracing at the proper points and to insure rigidity. The device is controlled by means of a handle which is secured to a rotating disc fastened in a brass cup integral with the damper.

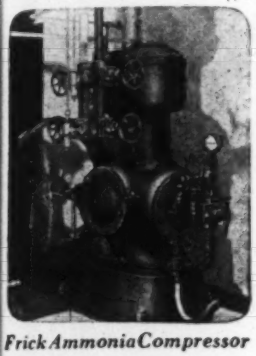
Electric Timers

No. 6530 — A four page bulletin covering electric

Frick Ammonia Compressors Serving a Large Hospital

Frick Freon-12 Compressors Air Condition an Office Building

Whether You Need Ammonia or Freon-12 Equipment, You Get What You Want with



Frick Ammonia Compressor

TRADE FRICK MARK **Refrigeration**

As builders of both ammonia and low-pressure systems, we are in an unbiased position in filling your requirements.

For the ultimate in satisfactory cooling equipment, put your problems up to the nearest Frick Branch or Distributor.

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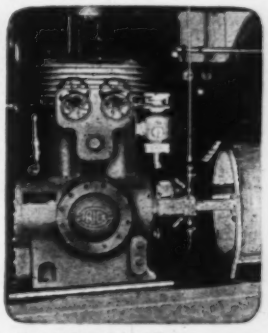
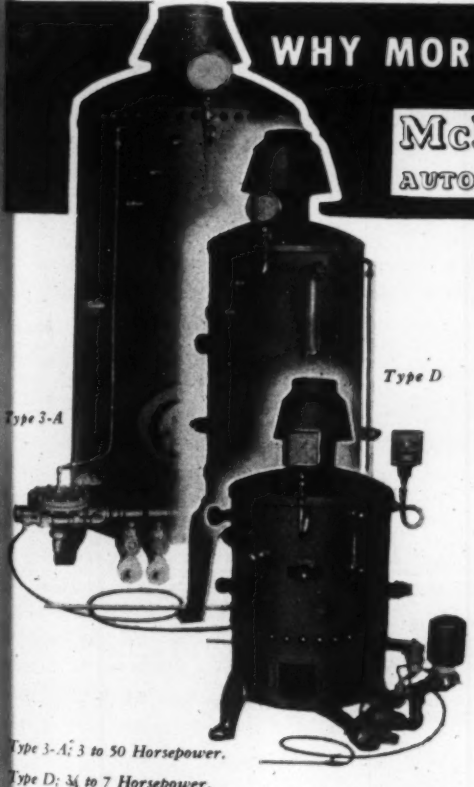


Frick Freon-12 Compressor

WHY MORE and MORE HEATING CONTRACTORS are installing Gas-Fired "STEAMBOILERPLANTS"

McKEE AUTOMATIC



Type 3-A

Type D

Type 3-A; 3 to 50 Horsepower.
Type D; 3½ to 7 Horsepower.
Type C—Same size as Type D, but faster steaming; ideal for gravity return.

They SAVE More Money for your Customers

"STEAMBOILERPLANTS" supply Hot, Dry, Steam *Fast* for many different applications, Right-At-The-Job. Thus they Save Space, Save Time, Save Fuel, Save Steam, Save Dollars.

Small tubes extract maximum heat from gases; raise efficiency, lower fuel cost.

A "Complete Package" — No "extras" to buy.

They MAKE More Money for YOU

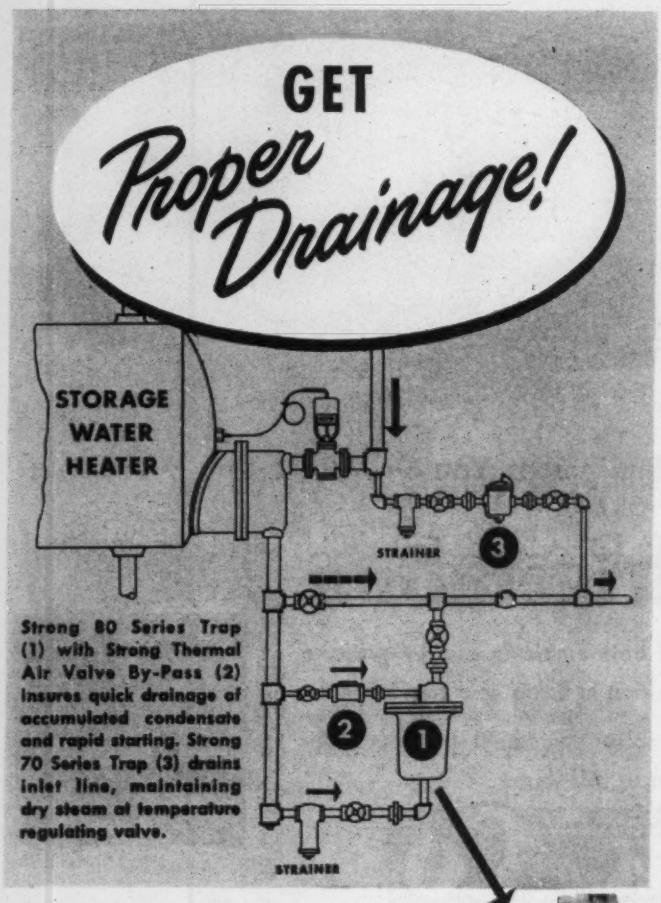
"STEAMBOILERPLANTS", built *Better Than Code,* have so many easily-demonstrated advantages that they *sell* faster. This means quicker turnover, more profits for you. They're easily installed; simply connect to gas and water supply. Their installation cost is low. You're sure of good service because Eclipse stands back of the entire installation.

Type C

Write for full data on "STEAMBOILERPLANTS — also on Eclipse complete co-operation with Heating Engineers and Contractors.

Eclipse Fuel Engineering Company
ROCKFORD ILLINOIS

McKee Eclipse

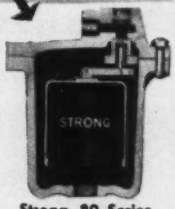


Strong 80 Series Trap (1) with Strong Thermal Air Valve By-Pass (2) insures quick drainage of accumulated condensate and rapid starting. Strong 70 Series Trap (3) drains inlet line, maintaining dry steam at temperature regulating valve.

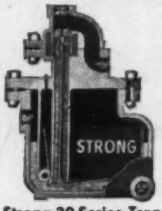
PROBLEM: Condensate accumulates in coils due to lack of pressure when thermostatic regulating valve is throttling or closed. *Improper drainage and water hammer result when thermostatic valve opens.*

SOLUTION: *Drain coils fast.* Use trap with four to eight times capacity of actual steam condensate rate. For medium or high pressures, either open or inverted bucket traps are suitable. *Use open bucket traps for low pressures.*

Completeness of the Strong trap line enables our engineers to recommend exactly the type or size you need—open or inverted bucket, closed float, float-and-thermostatic (blast), etc., forged, welded, cast or semi-steel construction. Bring your drainage problems to us for solution. Send for Strong Trap Catalog No. 67 today for complete details of *all* Strong traps.



Strong 80 Series Trap for medium or high pressures.



Strong 30 Series Trap for high, medium or low pressures.

STRONG, CARLISLE & HAMMOND COMPANY
1392 West 3rd Street
Cleveland 13, Ohio

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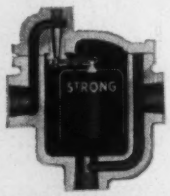
OTHER STRONG STEAM SPECIALTIES

Reducing Valve



70 Series Trap

Strainer

STRONG

timers has been issued by the R. W. Cramer Co., Inc., Centerbrook, Conn. Units are available for many general and specific industrial and commercial applications. Among the timers described and illustrated are interval timers, automatic reset timers, time delay relays, and running time meters, together with cycle, impulse, duplex cycle, percentage, and multi-contact timers.

Exhaust Fans and Blowers

No. 6531—Propeller type exhaust fans are described in bulletin 105 released by the Martin Fan & Blower Co., 4634 W. 21st Pl., Chicago 50, Ill. Bulletin 107 covers bucket type exhaust fans designed for handling large volumes of air quietly. Bulletin 121, also issued by the company, covers centrifugal blowers of both the forward and backward curve blade type. Capacities of these units range from 90 to 286,000 cfm.

Expansion Joint

No. 6532—A new eight page illustrated bulletin (No. 35-30D) on the "Adsco" internally-guided expansion joint for steam, water, oil, and other pipelines gives details of construction, dimensions, and list prices in sizes from 1¼ to 20 in., in single and double joints for working pressures up to 300 psi. The bulletin is available from the American District Steam Co., North Tonawanda, N. Y.

Flow Meters for Liquids and Gases

No. 6533—The Series 700 "Flowrator", constitutes a basic design of variable area flow rate meters which is said to be adapted to the diverse requirements of many industries. Catalog section 25-E, published by Fischer & Porter Co., Dept. 1J-C, Hatboro, Pa., includes descriptions and illustrations of the instruments, both assembled and disassembled. Numerous accessories such as a horizontal line adapter, steam heating coils, and alarm devices are also covered.

General Purpose Metal Framing and Pipe Supports

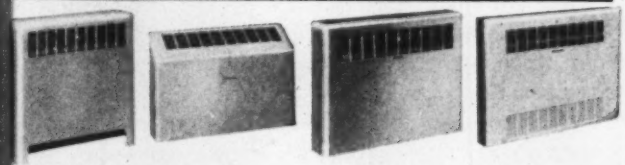
No. 6534—Unistrut Products Co., 1013 W. Washington Blvd., Chicago 7, Ill., has issued five descriptive folders covering the company's line of all purpose metal framing which is slotted throughout to facilitate installation and adjustment. Form GB-1 provides a general introduction to the product and to the many applications which include storage racks and shelving of all types. Form BT-2 gives details for using the members as storage racks. Form CI-1 covers the company's concrete inserts ranging in length from 3 to 20 in. These inserts are used to anchor members to concrete. Form S-3 is a small folder pictorially presenting some of the many applications. Form RPS-1 covers the company's roller pipe supports which are designed to handle pipe sizes from 1 to 12 in. These solid, tapered rollers are used with the metal framing to provide pipeline supports.

Grilles and Registers

No. 6535—Tuttle & Bailey, Inc., New Britain, Conn., manufacturer of air distribution devices for air condi-

"STREAMAIRE" CONVECTORS
Grow in Popularity

• An increasing number of architects and contractors are specifying "Streamaire" Convectors because they give extras that spell heating satisfaction. "Streamaire" Units are highly efficient and truly economical. They respond instantly to modern thermostatic controls . . . are engineered to circulate warm air by controlled convection, to level off temperature peaks by natural radiation. "Streamaire" Convectors are easy to specify, easy to install because they're standardized in four types, packaged individually to prevent damage. To aid identification, cartons are marked with model number and size. "Streamaire" Cabinets enhance the beauty of modern interiors. Fronts are removable for cleaning. Write today.



Free Standing, Type C, no wall recesses required. | Wall Hung, Type WS, sloping top, no blocking of air. | Wall Hung, Type W, easy to clean, one-piece panel. | Partially Recessed, Type S, easy to install in recesses.

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OIL COOLERS • GAS, GASOLINE, DIESEL ENGINE COOLING RADIATORS • HEAT EXCHANGERS
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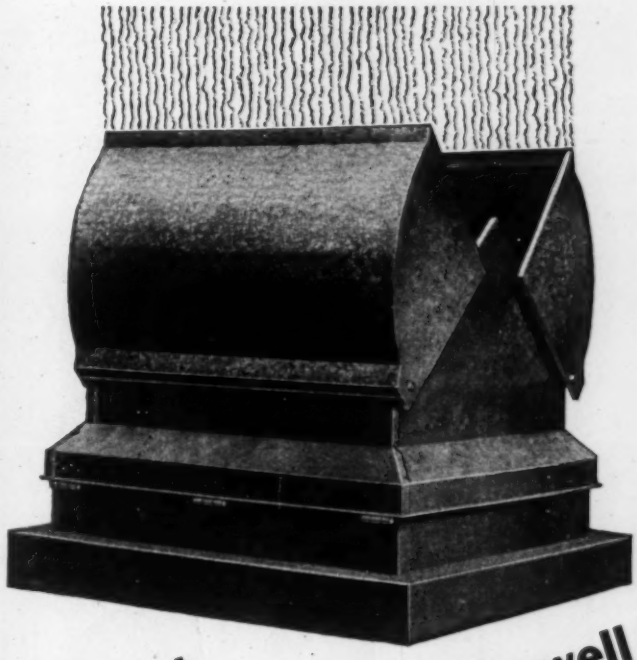
AND A COMPLETE LINE OF AIRCRAFT HEAT TRANSFER EQUIPMENT

YOUNG RADIATOR CO., Dept. 117-E, RACINE, WIS., U.S.A.
Sales and Engineering Offices in All Principal Cities



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It isn't always "wages" or "hours," or privilege questions that cause some factories to lose employees. Often it's a matter of "living conditions." Smoke, fume or heat-laden air that makes workers tired and sick can be moved out of your buildings by efficient Swartwout Ventilation.

The new Swartwout Ject-O-Valve forces unwanted elements outside before they spread through your work rooms. Elimination above the *source* of heat, fumes, dust, etc. draws fresh air to the area from outer walls where it enters. Workers have a chance to breathe and work in comfort—repay cost of ventilation through more and better production.

Ject-O-Valve is made in five sizes—14 capacities to select from, according to your needs. Motor and fan unit easily accessible for servicing. Write today for Bulletin 323.

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Swartwout *Controlled* **Air Circulation**
EQUIPMENT FOR EFFECTIVE ECONOMICAL VENTILATION OF INDUSTRIAL BUILDINGS

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ROTOJET

Rotojet spray nozzles are the ultimate in simplicity and efficiency. They provide excellent atomization through the high centrifugal force developed by the flow of the liquid. There are no moving parts, no adjustments. The action set up within the nozzle keeps it clean and clog-proof. Extra metal at points of wear gives Rotojet exceptionally long life. Rotojet nozzles are available with orifices from 1/16" to 1-13/16".

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Bulletin No. 450 gives you 8 pages of specifications, capacity tables, industrial applications, and other valuable information about Binks Standard Spray Nozzles. Drop a card in the mail today for your free copy of this helpful booklet.

BINKS MANUFACTURING COMPANY
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tioning, heating, and ventilating, has issued a 20 page bulletin (No. 47TF) on the recently developed line of "Tri-Flex" grilles and registers. Descriptions of the various units with performance data and list prices are included.

High Pressure Cast Steel Valve Bodies

No. 6536—Bulletin R-1, released by the Fisher Governor Co., Marshalltown, Iowa, describes Types D and DA cast steel 3000 psi and 6000 psi angle and globe pattern, single seated valve bodies with venturi seat rings having gasket-sealed construction and heavy guided "Micro-Form Pup" type inner valve.

Industrial Control Instruments

No. 6537—Catalog No. 8302 on industrial control devices, published by Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Wayne & Roberts Aves., Philadelphia 44, Pa., contains information on electric and pneumatic control systems. Control devices and safeguards are described and dimensional drawings, photographs, specifications, range charts, etc., are included. Among the electric controls covered are temperature, pressure and humidity controllers, engine safety cutoffs, float switches, low water cutoffs, the "Protectoglo" flame-electrode and photo-electrode, safety shutoff valves, "Modutrol" and industrial control motors and motorized valves. Pneumatic controls include temperature, pressure, and humidity controllers, "Grad-U-Motors" and "Grad-U-Trol" valves, relays, and switches. Numerous other switches, instruments, meters, and gages are also described.

Magnetic Motor Starters

No. 6538—The Master Electric Co., Dayton 1, Ohio, has issued a four page bulletin (Form No. 4705) on the company's line of a-c magnetic across-the-line motor starters which are of the solenoid type. The folder provides general information and discusses features such as overload protection, under voltage protection, remote control push button stations, and the use of a signal flag.

Neoprene Latex

No. 6539—The Vol. 38 issue of The Neoprene Notebook, published by the Rubber Chemicals Div., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., briefly describes the manufacture of products from neoprene latex. Also discussed are numerous industrial applications such as valve linings, wire mesh coatings, packing rings in blowoff valves, pump impellers, hose for handling hot plastic paint, and conveyor belts.

Plastic Protective Coating

No. 6540 — "Bituplastic", a new protective coating designed to waterproof and vapor seal, is described in a new bulletin issued by the manufacturer, Wailes Dove-Hermiston Corp., Westfield, N. J. (subsidiary of Koppers Co., Inc.). This coal tar pitch coating is designed for many protective applications including tanks, iron work, cooling towers, metal structures, and roofs. It is said to waterproof and dampproof any wall surface of metal,

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Precision and strength describe the design and construction of Meier Nu-Air Quiet Props. Their static-balanced blades of mirror-like aluminum are insulated from the cadmium spider and hub to guarantee accuracy and smooth, efficient performance. Available in 10" to 54" sizes . . . 11° to 34° pitch.

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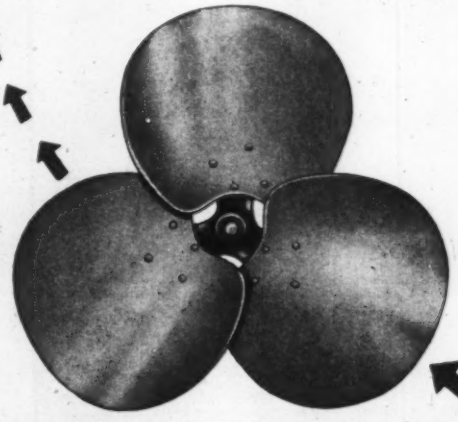
Write for Technical Bulletin No. 2100



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MEIER ELECTRIC & MACHINE CO., INC.

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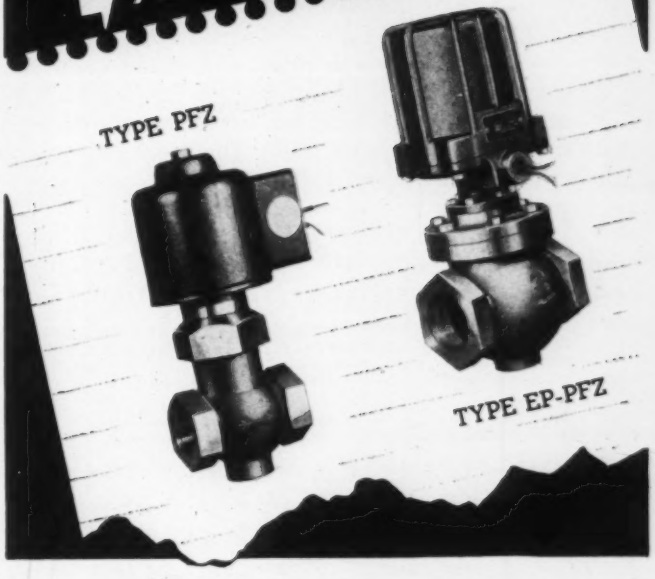
ASCO SOLENOID VALVES of the BULLETIN 8210 CLASS

IDEAL VALVES FOR CONTROLLING REFRIGERANT FLOW

Packless → Straight Through → Full Pipe Area



The Solenoid Valve serves well both as traffic cop and watch dog for refrigerant lines. Its action is sure and automatic when responding to temperature demands, shutting tight and staying tight or opening full as called for by the system.

The ASCO Line of Solenoid Valves for refrigeration systems is quite varied both as to types and sizes. The two illustrated are widely used; being designed for pressures up to 250 psi and temperatures up to 212 F. Standard valves are bronze with screwed connections. Type EP-PFZ valve is the explosion-proof type with valve construction similar to Type PFZ.

Write us about your refrigerant solenoid valve requirements. We are quite certain we have the valves that will fit into your system perfectly.

ASCO Solenoid VALVES

When in need of Automatic Transfer Switches, Remote Control Switches, Contactors, Relays, and Specialized Electromagnetic Controls, come to us.

Automatic Switch Co.

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masonry, or concrete. Physical properties and application data are included.

Pneumatically Operated Butterfly Valves

No. 6541—Heavy duty butterfly valves of steel body construction and designed for diaphragm motor valve operation are described in bulletin No. 77 issued by the Fisher Governor Co., Marshalltown, Iowa. A cable drive mechanism is used from the pneumatic motor to the rotary shaft of the butterfly valve.

Prefabricated Insulated Pipe Units

No. 6542—Designed to be of practical value to engineers and architects, a booklet of specifications for underground pipe distribution systems employing prefabricated insulated pipe conduit has been published by the Ric-wiL Co., Cleveland, Ohio. The booklet is a compilation of data arranged in tabular form with supplementary diagrams and charts. Typical of the information contained are tables of dimensions for one or more conduits in one trench, tables of maximum conduit capacities of wrought iron and steel pipe sizes, and standard prefabricated expansion loop details. Construction details of the company's insulated pipe units and available accessories are also given.

Propeller Fans

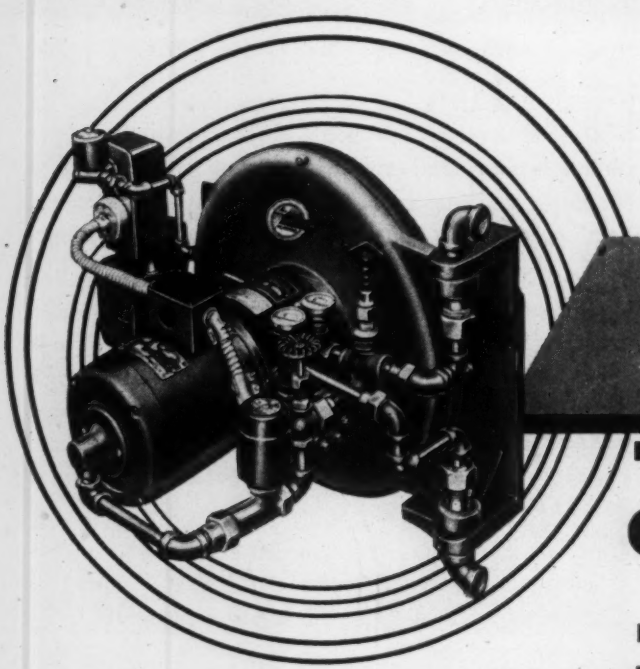
No. 6543—The 1947 line of propeller type fans offered by Emerson Electric Mfg. Co., St. Louis 21, Mo., is illustrated in color and described in detail in a new catalog (Unit X5749). The 28 page booklet gives design and construction features and performance data on the various types of desk fans, air circulators, ceiling fans, kitchen ventilators, exhaust and cooler fans. Ventilating fans and accessories are also included. A copy of the catalog may be obtained from the manufacturer by those requesting it on their company stationery.

Protective Materials for Steam Boiler Operation

No. 6544 — Saverite Engineering Co., 1030 Willow Ave., Hoboken, N. J., manufacturer and distributor of protective materials for use in connection with steam boiler operation, has issued a series of bulletins covering its line of compounds. Included are materials designed to eliminate soot and reduce flyash, to keep boiler plates clean and to arrest pitting and corrosion, to eliminate rust and scale in pipes carrying hot and cold water, to prevent steam line corrosion, to dissolve old sludge and prevent new sludge from forming, and to prevent corrosion and fungus growths on submerged surfaces such as in tanks and boilers. Also described is a refractory coating designed to prevent spalling and slagging. The company's graphite base "Joint Seal" and the rust preventative compound are said to be suitable for many industrial applications.

Radiant Heating System

No. 6545—The advantages of radiant panel heating systems are briefly covered in a folder issued by Pan-E



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Models Available

	GALLONS PER HOUR	BOILER H. P.	SQUARE FEET STEAM RAD.
MINIMUM	2	6	800
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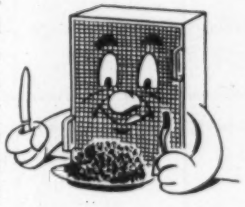
The filter with a husky appetite . . . for dirt



A STEEL MILL is the toughest test of all for an air filter. In and around a mill the air is constantly laden with abrasive grit and dirt. Yet this same air must be used to supply engines and compressors, to cool motors and generators.

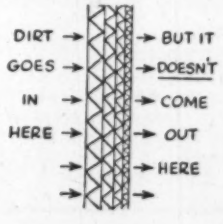
To make steel mill air fit for use takes a filter with a husky appetite for dirt. That's why so many plants specify *Air-Maze.*

ONE BIG PLANT near Pittsburgh uses over 400 Air-Maze filter panels to make certain that no harmful dirt reaches the insides of its mill motors. Each panel, only 20" square by 4" thick, collects more than 4 lbs. of grit and dust before it has to be cleaned.

Maintenance men everywhere prefer Air-Maze filters because they stop and hold practically all nuisance dirt with negligible effect on air delivery. Filters are all-metal, cleanable, last almost indefinitely.

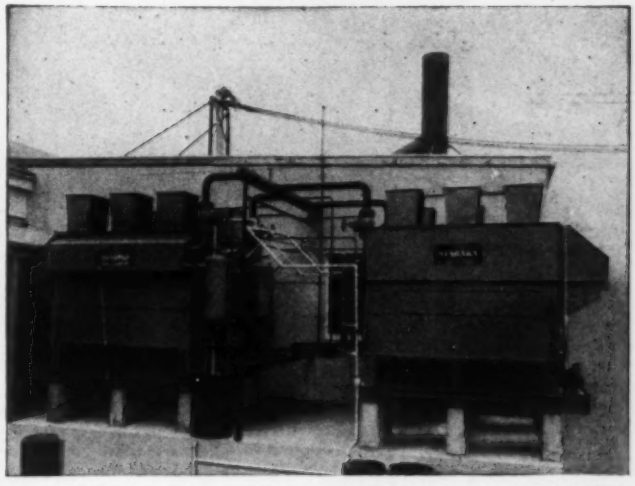
YOU MAY NOT have to deal with "steel mill air." But if you use air for any purpose, Air-Maze engineers can help you whittle down the high cost of dirt. Wherever air moves, dirt rides along—grinds away at machine parts, impairs efficiency, increases maintenance cost. Everyday Air-Maze protects ventilating systems, gear cases, blowers, instruments and many other types of industrial equipment from the damaging effects of airborne dirt.

HAVE YOU A FILTERING PROBLEM? Whether you build or use engines, compressors, hydraulic equipment, lubricating systems, *or any device using air or liquids* — the chances are there is an Air-Maze *engineered* filter to serve you better. Write Air-Maze Corporation, Cleveland 5, Ohio.



AIR-MAZE

The Filter Engineers



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This is possible because you use outdoor air as the cooling medium with the extra benefit of evaporative condensing! Condensing temperatures are lowered; condenser capacity is increased; head pressures are reduced —additional compressor capacity is the result.

Only the patented NIAGARA Duo-Pass makes this gain permanent because no other evaporative condenser lowers condensing temperatures to the point where deposits do not accumulate on condenser tubes. This does away with loss of time for cleaning and assures always full capacity.

Write for Bulletin 91-HP and 103-HP.

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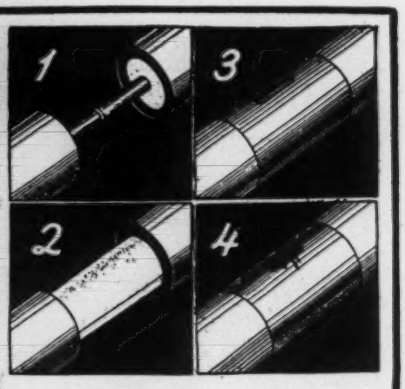

4 Simple Steps

1. Field joint ready for inspection. 2. Joint covered with standard pipe insulation. 3. Durant joint casing in place ready for asphalt. 4. Asphalt poured in slot making a perfect seal.

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For all your underground and exposed piping jobs you'll like DURANT Pre-Sealed Insulated Pipe. It is waterproof . . . reduces installation costs to a minimum . . . eliminates electrolysis and corrosion . . . requires very little trenching and field work . . . avoids extra cost of waste and breakage . . . comes to you ready to install. In short, D.I.P. is the *perfect pipe* for this type of job. Investgate D.I.P.! Write for details today.

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The ORIGINAL Pre-sealed Insulated Pipe

Heat Corp., P. O. Box 4090, Portland 8, Ore. The company manufactures radiant panel grids designed to fit all average installations.

Ram Feed Stokers

No. 6546—Bulletin No. S-32 of the Brownell Co., 408 N. Findlay St., Dayton 1, Ohio, describes Types LR and LR1 ram feed stokers having capacities of 75 to 315 boiler horsepower. Outstanding features are said to include automatic air volume control and intermittent coal feed control.

Refrigeration Compressor Condensing Unit

No. 6547—Model WUA two cylinder reciprocating compressor with air cooled condenser is designed for use with "Freon-12" and is available in sizes from ¼ to 2 hp. This refrigeration unit is briefly described in a four page bulletin issued by Worthington Pump and Machinery Corp., Harrison, N. J.

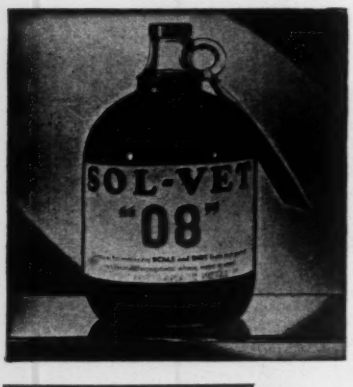
Refrigeration Controls

No. 6548—A booklet containing information on more than 20 control instruments for use in the cooling and refrigeration fields has been released by Minneapolis-Honeywell Regulator Co., 2604 4th Ave. S., Minneapolis 8, Minn. Containing charts comparing 1946 and 1947 underwriter's codes, the catalog contains information on controls and control systems for freezer cabinets, display cases, liquid coolers, air conditioners, and equipment of a similar nature. Horsepower ratings of the

CLOGGING WORRIES ENDED

on Cooling Towers and Condensing Units with

SOL-VET "08"



Look to the advantages of using Sol-vet "08" if scale slime, rust, or algae are clogging up your cooling towers or condensing units. Sol-vet Service rates high with engineers because it offers the services of one of the best equipped water laboratories in the country. Thorough testing of your water can help determine the proper Sol-vet Service Formula to eliminate clogging, boost equipment capacity, and save needless shutdowns for overhauling. Write us today for information on Sol-vet Service with free analysis and complete recommendations for your specific scale removal problems.

GUARANTEED EFFECTIVE
If you find SOL-VET "08" not exactly as represented, when used according to instructions, and full, accurate report is given within 30 days from date of purchase your money will be refunded.

GUARANTEED HARMLESS
when used as directed, to all water conducting materials in water cooled equipment.

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Hand powered, the A-30 bends ½ to 2" standard pipe sizes at a radius of 5 to 1, up to 180°. Special radii can be supplied within these sizes.

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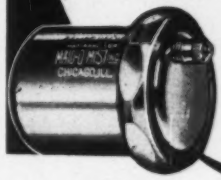

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As air accumulates in radiators or pipes, it is AUTOMATICALLY VENTED when you use these inexpensive No. 27s. Your customer gets better heating and saves fuel.

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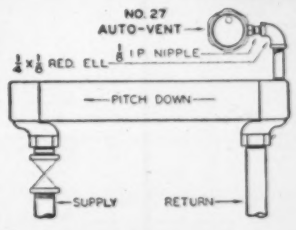

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The recessed brass seat is an important feature of Jefferson Specialty Unions. It's incorporated in the versatile 45 degree male and female union ell shown at left; once this unit is installed you know there won't be any leaks because the brass seat seals TIGHT! It's impossible to dislodge it, too, because it's located away from the runway of the fitting . . . no chance of pipe ends unseating it. Install Jefferson Unions at the start and make sure your jobs are secure against leaks and shutdowns. Please write for more detailed information.

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GASKET REPLACEMENT

The only tool that takes the guesswork out of replacing gaskets, regardless of line pressure or location. Flanges are parted quickly and held in perfect alignment without damage to faces... shock and jarring of pipe lines are eliminated... there is no danger from flying wedges ... no sparks caused by hammer blows. FLANGE-JACKS eliminate costly shutdowns, make possible fast, economical repairs in hard-to-get-at locations... offer maximum safety.

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Standard No. 20 $24.00 a pair
Giant No. 30 $48.00 a pair
See your distributor for trade discounts

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Williams
Flange-Jacks

various instruments are listed, and safety features are discussed.

Self-Aligning Pillow Blocks

No. 6549—Prentice self-aligning pillow blocks for blowers, air conditioning equipment, and machinery are described and illustrated in a data sheet released by the national distributors, Western Thermal Equipment Co., 1701 W. Slauson Ave., Los Angeles 44, Calif. The porous bronze bearings are said to be fully flexible though anchored firmly in place. Synthetic rubber pillows are used on these bearings which are available in a variety of shaft sizes from ¾ to 1⅞ in.

Sludge and Scale Removal

No. 6550—Apex Engineering Co., 205 W. Wacker Dr., Chicago 6, Ill., has issued a leaflet covering its "Rid-Al" service designed to eliminate sludge, scale, grease, oil, and other wastes incidental to heat exchange equipment. Chemical solutions are used to clean and protect equipment such as condensers, water heaters, cooling and heating coils, heat exchangers, evaporators, steam lines, condensate returns, traps, turbines, etc.

Solderless Wiring Devices

No. 6551—Compiled for design and production engineers, Aircraft Marine Products, Inc., 1532 N. 4th St., Harrisburg, Pa., has announced a selection data book on its entire line of solderless wiring devices. This

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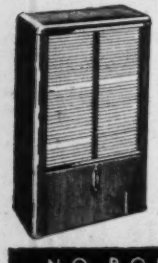
THE AUTOMATIC
GAS FIRED HEATER

with the BIG, QUIET FAN

As the "Big, Quiet" Fan moves a generous quantity of air quietly through the multi-section heat exchanger, the room is comfortably and uniformly warm. Only Reznor Suspended and Floor Type Heaters have the ply-metal, corrosion-resistant, air-tight, chatter-proof, indented type tubes—for more heat quietly and easily distributed.



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Gas fired unit heaters

SUSPENDED OR FLOOR MODEL

A SIZE FOR EVERY NEED

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NO BOILERS • NO STEAM LINES
NO FUEL STORAGE • NO FIRE TENDING

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25 H.P. Unit Illustrated

Air Conditioning and Refrigeration
CONDENSING UNITS

With Advanced Refrigeration Compressor Design

All Schnacke units have replaceable refrigerant-cooled steel cylinder sleeves, complete pressure lubrication, balanced forged crankshafts, individual cylinder liquid relief, individual cylinder valve cage assemblies, built-in suction strainers, sealed crankcase, balanced pressure shaft seal, insert type bearings, water or air cooled heads, etc.

All Vital Service Parts Interchangeable

Shaft seals, pistons, rods, bearings, valves, valve assemblies, cylinder sleeves, etc., are completely interchangeable in Schnacke unit from 5 through 50 H.P.

Engineering data sent promptly upon request from engineers, distributors, dealers, or contractors.

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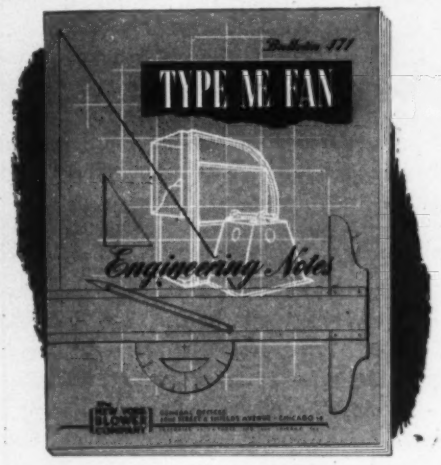

Something New in Fan Bulletins

Bulletin 471 contains complete performance tables on Type ME Fan together with useful engineering data. It also illustrates and describes the new and improved PL (Power Limiting) Wheel which operates at medium speeds and higher efficiency for a wide range of applications.

Your copy sent promptly upon request.

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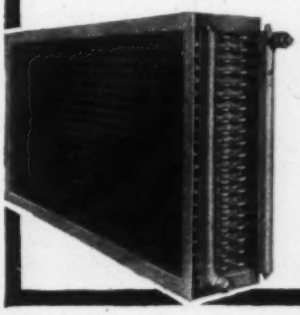

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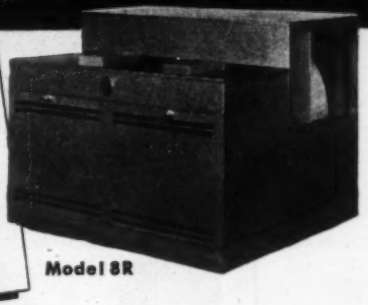

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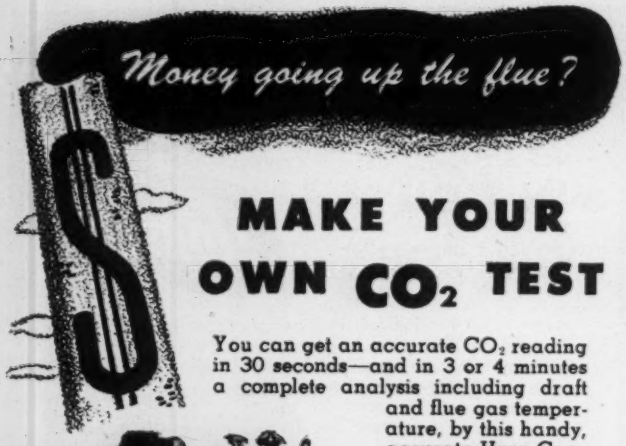

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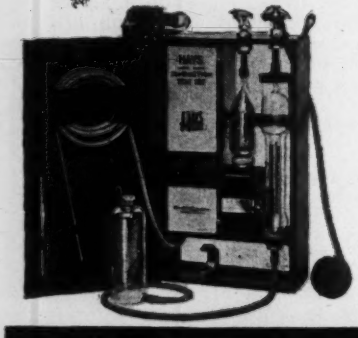
You can get an accurate CO_2 reading in 30 seconds—and in 3 or 4 minutes a complete analysis including draft and flue gas temperature, by this handy, accurate Hays Combustion Test Set.

Reveals efficiency of combustion—tells how much money is going up the flue.

A new booklet "ABC of CO_2" is important reading — permits you to figure actual fuel loss. Write for it.



The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

plastic-bound volume displays the various types of solderless terminals, their features, and their applications in a series of illustrated charts, index-tabbed for quick reference. Included are descriptions, complete with photomicrographs, of the types of pressure "crimps" developed by the company for installing the terminals in a variety of wiring applications. The data book also contains a selector chart and actual samples of the terminals.

Steam Specialties

No. 6552—Bulletin No. 715 on steam specialties has been issued by Wright-Austin Co., 315 W. Woodbridge St., Detroit 26, Mich. Representative types of traps, separators, and boiler trimmings from the company's line of specialties for power plants and steam heating and processing equipment are covered. Three steam traps and three separators, together with 22 other products, are described and illustrated.

Strainers

No. 6553—The Cash-Acme Type SY strainer, built to conform to standard cast iron screwed fitting specifications for pressures up to 250 psi, is described and illustrated in bulletin No. 224 released by the A. W. Cash Valve Mfg. Corp., 666 E. Wabash Ave., Decatur, Ill. The iron body strainer is cadmium plated both inside and out, is furnished with a blowdown for easy cleaning, and may be obtained with various types of screens. The bulletin also covers the company's Type S strainer and lists other bulletins which are available.

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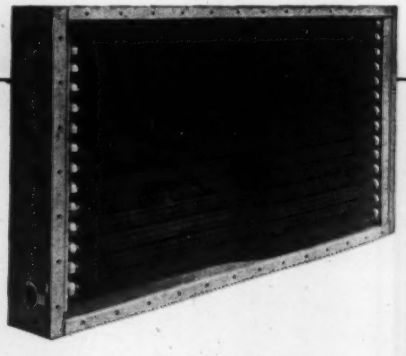

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10 TON UNIT

For contractors and owners who want better performance, longer life and more uniform satisfaction, ROGERS Conditioners are noise-proofed, vibration dampened. Large filter and coil area, rugged construction and economical operation. Require minimum floor space. HEATING COIL AND HUMIDIFIER EASILY INSTALLED FOR YEAR ROUND CONDITIONING.

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A most efficient unit using triethylene glycol (TEG) as dehumidifying agent and for sterilization of air. Gives automatic, *complete and independent control of temperature and humidity* when used with ROGERS conditioners. Can be used separately where dehumidifying only is wanted. Particularly useful in industrial processing or where accurately controlled humidity is desirable. Easy to install.

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Manufacturers of Equipment for Air Conditioning, Refrigeration, Heating and Ventilation.

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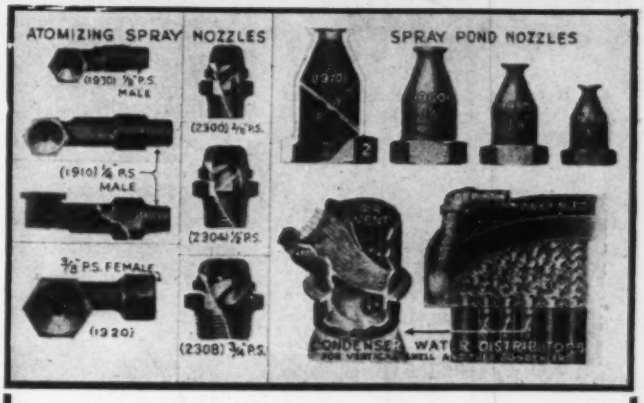
QUALITY always wins! MARTOCELLO Products are fully DEPENDABLE



ATOMIZING SPRAY NOZZLES, SPRAY POND NOZZLES, and CONDENSER WATER DISTRIBUTORS
For Vertical Shell and Tube Ammonia Condensers

ALL MARTOCELLO SPRAY NOZZLES are manufactured with precision and of a design which has been thoroughly tested for maximum results and durability. They are guaranteed to give satisfaction. Successful, efficient results depend largely upon selecting the proper number, type and size of Nozzles suitable for your installation.

THE MARTOCELLO CONDENSER WATER DISTRIBUTORS are now used as standard equipment by Progressive Refrigerating Engineers in solving their Manpower problem, because they require no attention and assure users of the lowest Condenser Operating Pressures and Minimum Power Cost.

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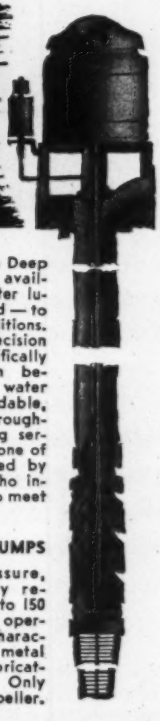

Sizes 4" to 24"

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HORIZONTAL SPLIT CASE
Single & Two Stage
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APCO TURBINE-TYPE PUMPS

For high pressure, small capacity requirements (up to 150 g.p.m.). Wide operating range characteristics. No metal to metal contact. Handles non-lubricating liquids without wear. Only one moving part—the impeller.

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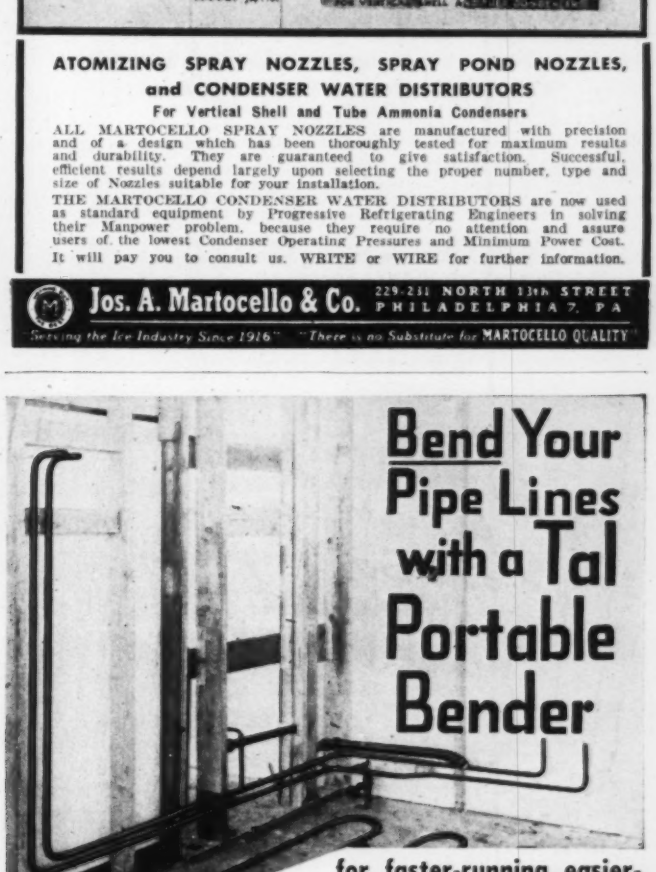

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for faster-running easier-going installation or repair work.

Bending is both the fastest and the easiest way of handling pipe . . . and you gain even more time with a Tal portable bender, the simplest, fastest-working machine. Anyone can handle a Tal—even first day apprentices can make perfect, true bends, cold, to any radius up to 180° in one single operation. A great on-the-job tool, this portable machine eliminates the use of bends and fittings, reduces up to 80% the need for welds, handles all wrought iron or steel pipe from ¾" to 3". No wonder thousands are already being used by alert contractors everywhere. Write for illustrated data bulletin. Dept. HPA-6.

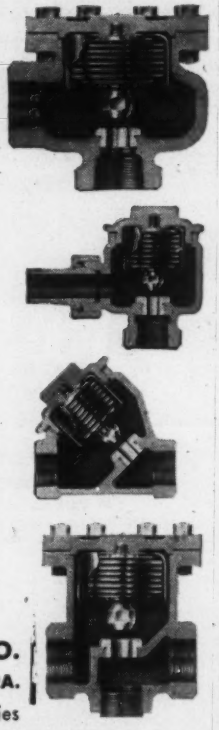
TAL **Prestal Bender, Inc.** Milwaukee 2, Wis.

Catalog 444 Shows How to

CUT HEAT-UP TIME

OF

Unit Heaters and Pipe Coils



Here are 3 of the features of Nicholson thermostatic steam traps, which account for their record of savings in heat-up time:

1) LARGER VALVE ORIFICES, resulting in 2 to 6 times average discharge capacity.

2) NO AIR BINDING, discharge air and non-condensable gases as efficiently as condensate.

3) NO WATER-LOGGING, slight temperature difference opens valve.

5 types: size 1/4" to 2"; pressures to 225 lbs. Weight- and piston-operated traps for higher pressures and larger pipes. For Nicholson's complete, service-tested line see Catalog 444 or Sweet's.

W. H. NICHOLSON & CO.
198 OREGON ST. WILKES-BARRE, PA.
Valves • Traps • Steam Specialties

Time Cycle Controllers

No. 6554—The Bristol Co., Waterbury, Conn., has published a 12 page bulletin (No. C305) on its new line of Model C500 Impulse-Sequence time cycle controllers. The booklet is illustrated with line drawings to show principles of operation and application for the unit which is designed for tire presses, plastic molds, and many general process applications.

Uses of Steel

No. 6555—Recently published by the steel jobbing firm of Joseph T. Ryerson & Son, Inc., Box 8000-A, Chicago 80, Ill., is an eight page newspaper illustrating many end uses of steel with a series of action type photographs. A copy of this Steel Pictorial No. 19 may be obtained from any of the company's 13 plants.

Valve Reference Chart

No. 6556—A 20 page valve cross reference chart contains a complete listing of valve numbers as used by the Ohio Injector Co., Wadsworth, Ohio, manufacturer of a line of steel, iron, and bronze valves. The valve numbers are listed in order and descriptions are included. In addition, many valve figure numbers of leading manufacturers are listed with the company's corresponding figure number.

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AUTOMATIC AIR RELIEF VALVE

FOR ALL HOT WATER SYSTEMS
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